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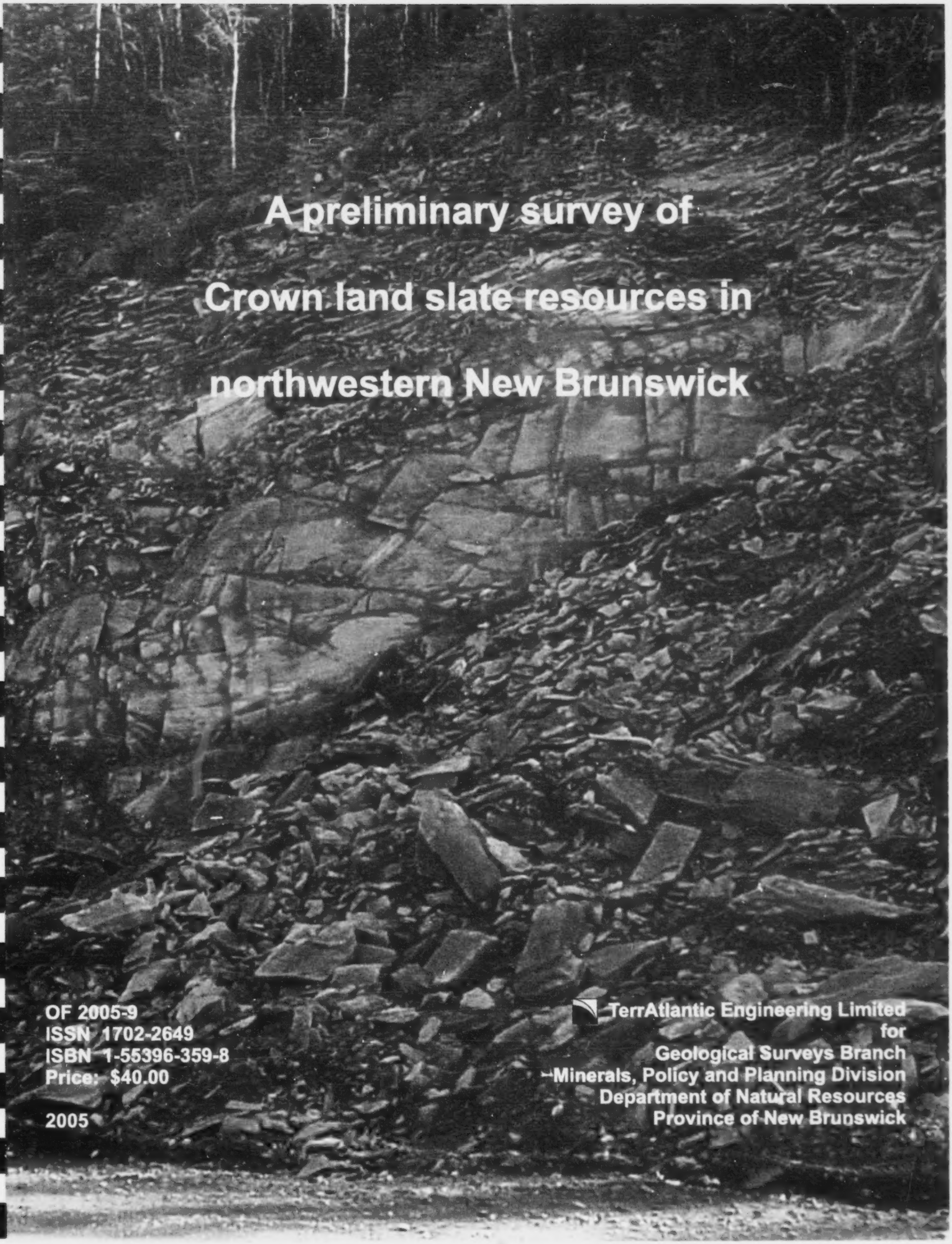

A preliminary survey of Crown land slate resources in northwestern New Brunswick

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2005

TerrAtlantic Engineering Limited
for
Geological Surveys Branch
Minerals, Policy and Planning Division
Department of Natural Resources
Province of New Brunswick

A PRELIMINARY SURVEY OF
CROWN LAND SLATE RESOURCES
IN NORTHWESTERN NEW BRUNSWICK

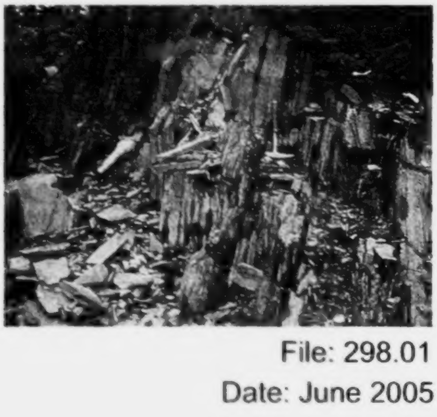
a report

submitted to the

New Brunswick Department of Natural Resources

by

TerrAtlantic Engineering Limited



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Prepared for:

Minerals, Policy and Planning Division
Department of Natural Resources
Province of New Brunswick

Hon. Keith Ashfield
Minister of Natural Resources

June 2005

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ABSTRACT

Interest in assessing New Brunswick's potential for marketable slate and related natural stone resources is driven in part by a growing domestic and regional demand for natural stone products in eastern Canada, the northeastern United States, and elsewhere.

Although extensive areas of early Devonian, low-grade metamorphosed, stratified sedimentary clastic rock, including slate or slate-like materials, are distributed throughout northwestern New Brunswick, assessment of their slate development potential for various natural stone products is limited.

A very preliminary regional reconnaissance has resulted in the recognition of thirty-seven (37) slate or slate-like exposures that have been qualitatively rated and further categorized with respect to various site development criteria. Almost 40% of these sites have been classified as having a "good" to "fair" development potential depending on the type of natural stone product considered. Most of these favoured sites occur in the eastern part of the study area where more detailed exploration and evaluation is required to understand and appreciate the true nature of this particular resource.

RÉSUMÉ

L'intérêt à l'égard de l'évaluation du potentiel d'ardoise marchande et de ressources de pierre naturelle connexes du Nouveau-Brunswick, repose en partie sur une demande intérieure et régionale croissante à l'égard des produits de pierre naturelle dans l'Est du Canada, dans le Nord-Est des États-Unis et ailleurs.

Même si des secteurs étendus de roches clastiques sédimentaires stratifiées et métamorphisées de qualité inférieure du Dévonien précoce se répartissent partout à l'intérieur du Nord-Ouest du Nouveau-Brunswick, l'évaluation de leur potentiel d'exploitation ardoisier aux fins de l'obtention de divers produits de roche naturelle a été limitée.

Une inspection de reconnaissance régionale très préliminaire a permis de repérer 37 affleurements d'ardoise ou de roches ardoiseuses dont on a ultérieurement évalué la qualité et qu'on a classés en fonction de divers critères de mise en valeur des emplacements. Près de 40 % de ces emplacements ont été classés comme endroits présentant un potentiel de mise en valeur « bon » à « passable », selon le type de produit de pierre naturelle considéré. La majorité des emplacements privilégiés se trouvent dans la partie orientale du secteur d'étude, où des travaux d'exploration et d'évaluation plus détaillés s'avèrent essentiels pour comprendre et juger la véritable nature de ces ressources particulières.

A preliminary survey of Crown land slate resources in northwestern New Brunswick

Introduction:

The use of various natural stone products in construction and for landscaping is becoming more popular in North America. New Brunswick's diverse geologic setting and its strategic position beside the very large consumer market of the northeastern United States make it a potential source of these natural stones. One such product is slate.

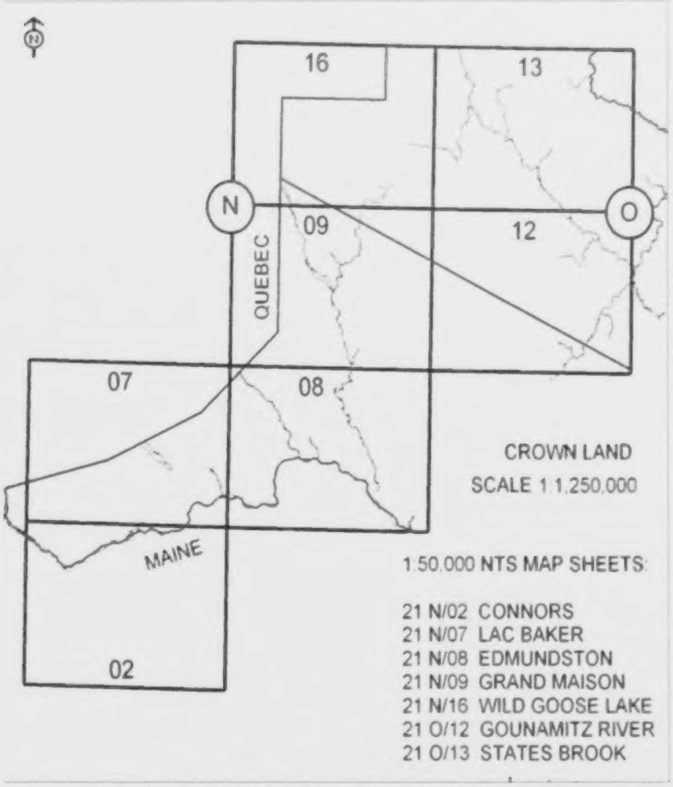
Slate is a fine-grained metamorphic rock that is most commonly derived from shale. It is composed of fine-grained minerals such as micas, chlorite, and quartz, aligned along a preferred orientation which gives rise to a well developed fissility or slaty cleavage. The ability of slate to split into smooth surfaced slabs and thin plates of variable size and thickness is its most widely recognized and most useful characteristic. Slab thicknesses of a few millimetres to several centimetres can be achieved by this splitting process. Slates and "slate-like" rocks are generally grey to black in colour, but also occur in shades of blue, green, brown and buff. A variety of textures may occur. In this study the survey has been broadened to include less fissile "slate-like" rocks that may also have some potential for development.

Traditionally used as a roofing material, slate is becoming a product of choice for flooring, cladding, counter-tops and for many landscape applications. Although used in New Brunswick on a local basis by early European settlers, primarily as a roofing material, the Province's slate resource has not yet been fully evaluated. Extensive areas of metamorphosed sedimentary clastic rock including slates are distributed throughout northwestern New Brunswick. The presence of a major slate operation developed in geologically similar terrain near the New Brunswick-Quebec border suggests that New Brunswick might also better develop this part of its mineral industry.

This project involved a preliminary regional examination of potentially marketable slate or equivalent materials in parts of northwestern New Brunswick. The objective was to gather information that might: (a) assist in identifying a potential slate resource, thereby expanding and adding diversity to New Brunswick's mineral industry ; (b) provide a means to respond quickly and effectively to resource enquiries; and (c) to stimulate and encourage potential development interest. It was hoped that the study could become a catalyst for change, contributing to the further development of this useful resource.

Scope and methodology:

In addition to locating suitably fissile materials of marketable quality, the successful development of natural stone resources depends on a number of factors including: (a) the availability of the land; (b) the presence or absence of potentially conflicting land uses; (c) the nature of the site access; and (d) the location of the site relative to potential markets. When these conditions are optimized, primary raw material cost(s) may be low enough to make the development of a quarry feasible.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21 N/02 CONNORS
21 N/07 LAC BAKER
21 N/08 EDMUNDSTON
21 N/09 GRAND MAISON
21 N/16 WILD GOOSE LAKE
21 O/12 GOUNAMITZ RIVER
21 O/13 STATES BROOK

Figure 1 - Map showing the extent of the slate resource study area and the distribution of Crown lands in northwestern New Brunswick

For the purposes of this preliminary survey it was decided to restrict the investigation to those potentially favourable slates and slate-like rocks occurring on Crown lands. Such lands are generally somewhat remote from areas of potential land use conflict, and a developer may be able to acquire the resource at reasonable cost based on a fixed royalty rate through established regulatory procedures. This may to some extent offset the effect of the higher transportation costs that might be associated with quarry development in a relatively remote area.

The study area was that Crown land located within the area shown in Figure 1 where early Devonian, deep water clastic marine sediments of the Fortin Group are widespread.

Approximately 50 percent of the overall area is Crown land, most of which occurs northeast of the Restigouche-Madawaska county line.

It was not intended that an exhaustive examination or mapping of the entire (5,000 km^2 of which 2,840 km^2 is Crown) study area be undertaken. Rather, the intent was that the close examination of a number of representative slate exposures would lead to a meaningful understanding of the nature, quality and distribution of the resource within the study area.

In order to meet the study objectives the following five tasks were undertaken:

- Information review: examination of the available geologic data; personal communications with a number of the geologists responsible for the mapping; a visit to the slate quarry at St. Mark du Lac Long, Quebec; and the review of general information on the optimum characteristics of slates for various applications;
- Evaluation of the area geology: this leading to the determination that the unit of prime interest from a slate potential point of view was the Temiscouata Formation of the Fortin Group; assembly of a GIS project to identify target areas for preliminary field reconnaissance activity;
- Evaluation of marketing issues: a review of the Quarriable Substances Act; a brief description of the current state of slate production in northeastern North America; generation of a "market overview" table; preparation of a list of the major producers and distributors within the selected "market area" and the identification of the locations of each;
- Field reconnaissance: each selected site was visited by our geologist and senior technologist; documentation of the status of relevant features of the rock exposure on a pre-designed form; photographs were taken and representative rock samples recovered for analysis of chemical, physical and mechanical properties; and
- Analysis and reporting: the data were assembled, representative samples of rock were tested in the laboratory, and a report was prepared.

The slate industry:

Uses and applications of slate and slate-like materials

Slate is commonly used in two forms: dimension stone and crushed or finely ground. Crushed to granular sized slate is commonly used in resurfacing driveways and tennis courts, and in coating roofing and siding materials. Finely ground slate has been used as a inert filler in paint, rubber, polishes and abrasive soaps. The higher value applications however are the dimension stones and these are the focus of this study.

A recent commodity study (USGS, 2003) breaks down the dimension slate industry into five different uses as shown in Table 1. These uses are briefly discussed in turn.

Table 1 - Typical end uses of dimension slate and slate-like rock

CATEGORY	END USE OR PRODUCT
Structural and Sanitary	Countertops, sinks, wash basins, urinals, cladding, coping, sills, slabs, stair-treads and risers, and fireplace hearths and surroundings.
Flagging	Outdoor patios, porches, terraces, pavilions, driveways, walkways, stepping stones and public buildings.
Flooring	Ideal flooring material due to their hardness, durability, performance and natural beauty.
Roofing	Slate roofs resist the assaults of rain, wind, and snow, and have unmatched durability.
Other	Chalk boards, memorials, signs and plaques and decorative stone of various kinds.

Structural and Sanitary

Slate has become a popular material in kitchens and bathrooms, the main uses being sinks and countertops. In the past these sanitary uses included urinals and lavatories for which slate's non-odorous, non-absorbent, easily cleaned properties were thought to be ideal. This versatility and ability to be manufactured to exact specifications makes it a very functional product. Slate is also utilized for a wide range of structural products including cladding, coping, sills, and fireplace hearths. Slate has been used for stair-treads and risers for centuries, its non-slip properties being considered superior to wood, iron or marble for this purpose. (The Manufacturer and Builder, Vol. XVII, January 1885).

Flagging

Slate has been used in driveways and walkways for many centuries. Its texture, durability and resistance to the environment make it a favourable construction product. Flagging slate is also easy to maintain.

Flooring

Slate has been used as a flooring material in Europe since Roman times (http://www.llechicymru.ingo/lHist.english.htm). The durability and beauty of slate adds to its appeal as an interior flooring product. Flooring slate is now widely used in both commercial and residential construction.

Roofing

The use of roofing slate also dates back to Roman times. Early settlers of North America brought with them the cultural exposure to the material and the technological expertise of slate production. Slate is among the most durable and visually pleasing roofing materials

(Figure 2). Properly installed slate roofs are characterized by minimal maintenance and a longevity often exceeding several decades. During the late nineteenth and early twentieth centuries, parts of northeastern North America where slate resources are relatively abundant, witnessed slate as a material of choice not only for institutional, ecclesiastical and government buildings but also for residences, barns and other structures where permanence was desirable.

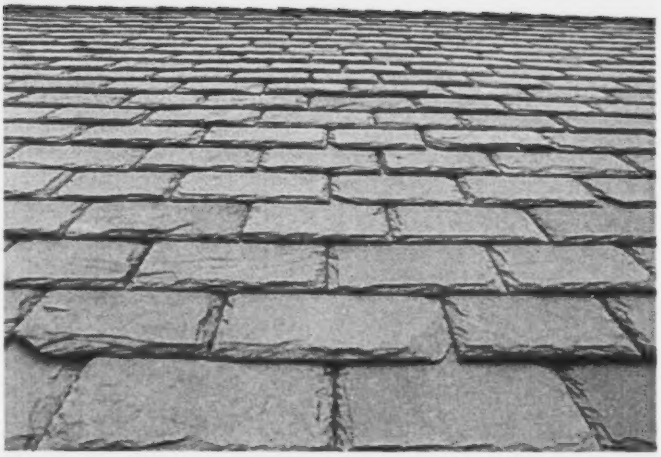


Figure 2 - Slate is among the most durable and visually pleasing roofing materials

Other

Slate has most notably been used for chalk boards over the years and school slates are still being manufactured today. It has also been used for surfacing pool and billiards tables and for creating memorials, signs, and other decorative pieces.

There are few data illustrating the relative importance of these uses on a worldwide basis, but in the United States, most slate production by quantity is used in flooring while roofing tiles represent the greatest production value.

Specifications for various slate applications

Depending on the end use of the slate or slate-like rock, marketable material would need to comply with one or more of a variety of test criteria, likely, including those established for absorption, flexural strength/modulus of rupture, and for abrasion and acid (i.e. weather) resistance, as described in the standard specifications for slate dimension stone (ASTM C629) and/or for roofing slate (ASTM C406). The specification for slate dimension stone is summarized in Table 2.

Table 2 - Standard specification for slate dimension stone - ASTM C629

PHYSICAL PROPERTY	TEST REQUIREMENT	CLASSIFICATION	ASTM TEST METHOD
Absorption, maximum %	0.25% 0.45%	I Exterior II Interior	C121
Modulus of Rupture, minimum, psi [MPa]			C120
Across grain	9000 [62.1]	I Exterior and II Interior	
Along grain	7200 [49.6]	I Exterior and II Interior	
Abrasion Resistance	8	I Exterior and II Interior	C241
Acid Resistance, max, in [mm]	0.015 [0.38] 0.025 [0.64]	I Exterior II Interior	C217

The grades of roofing slates are judged by the absorption and softening (acid resistance) characteristics (refer to Table 3).

Table 3 - Standard specification for roofing slate - ASTM C406

PHYSICAL PROPERTY	TEST REQUIREMENT	CLASSIFICATION	ASTM TEST METHOD
Absorption, maximum %	0.25% 0.36% 0.45%	Grade S_1 (75 year service life) Grade S_2 (40 to 75 years) Grade S_3 (20 to 40 years)	C121
Modulus of Rupture, Across grain, minimum, psi [MPa]	9000 [62.1]	Grades S_1, S_2 and S_3	C120
Acid Resistance, max, in [mm]	0.002 [0.05] 0.008 [0.20] 0.014 [0.36]	Grade S_1 (75 year service life) Grade S_2 (40 to 75 years) Grade S_3 (20 to 40 years)	C217

Comprehensive testing was considered to be beyond the scope of this preliminary survey, but it was resolved that some limited laboratory work should be undertaken to permit a comparison of the observed rocks with those from other sampled locations or from a few actively developed quarries for which test data were available. Additional laboratory data would naturally be required if and when future investigation led to the identification of a particularly promising area for quarry development.

Common slate mining practices and processing methods

Modern production techniques in quarry development have increased productivity without the need for a large skilled labour force. Large rough blocks of slate are extracted from the quarry using rotary saws. The blocks are transported to the processing facility where they are trimmed and split using hydraulic splitters. The end products are then packaged appropriately for shipment.

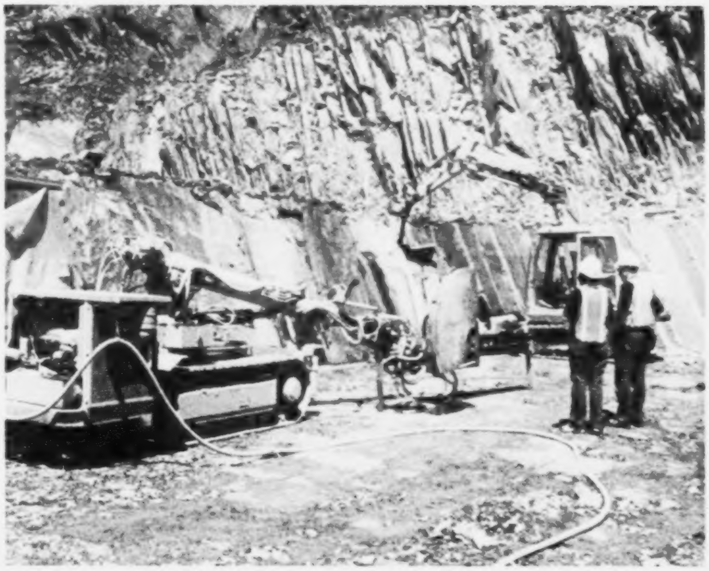


Figure 3 - Methods of working a slate deposit

Marketing slate materials

World production

There is a lack of reliable statistical information concerning the world's building stone industry, with much of the data being lost within general statistics which may include production figures for aggregate or crushed rock products (BGS, 2004). Nevertheless, the world production of dimension stone in 2002 was estimated to be approximately 77 million tonnes (Dolley, USGS, 2003). The top five producing countries in that year, in descending order by tonnage, were China, Italy, India, Iran and Spain, together accounting for 72 percent of world production (Dolley, USGS, 2003). The United States ranked 11th in world production in that year, and Canada 28th (IMM Camara website, 2005).

In a 1988 study, the worldwide production of dimension slate was estimated to be 500 to 700 thousand tonnes per year (Atlantic Consulting Economists Limited, 1988) which likely represented less than one percent of the dimension stone total. By 2003, the world-wide production of dimension slate was in the 1.2 to 1.4 million tonnes per year range. The world's largest producer in 2003 was Spain which had increased its production from about 300,000 tonnes in the mid 80's to over 800,000 tonnes in 2002. Spain's slate production now represents about 64 percent of the world production. Although China is known as a significant slate producer, no reliable production information was available for review.

The demand for slate is dependent on construction trends. Europe and North America make up the two major slate markets. Historically, the main exporters have included Spain, Italy and Brazil but in recent years China, India, and South Africa have become more important. The major roofing slate exporting countries in 2002 were, again in decreasing order of importance, Spain, China and India.

World dimension slate production quantities are presented in Table 4.

Table 4 - Dimension slate production by country (tonnes)

COUNTRY[4]	1996	1997	1998	1999	2000	2001	2002	2003
Spain	705,000	555,000	615,000	600,000	751,000	790,000	828,470	n/a
Italy	107,000	100,000	100,000	100,000	100,000	100,000	100,000	n/a
UK	83,000	85,000	69,000	70,000	70,000	84,000	80,000	n/a
Germany	90,000	70,000	70,000	70,000	70,000	70,000	70,000	n/a
Brazil	50,000	50,000	50,000	50,000	50,000	50,000	50,000	n/a
China[3]	18,656	20,817	26,154	46,200	58,457	60,705	76,348	119,309
South Africa	37,800	11,000	23,547	24,500	24,952	40,984	24,386	50,880
Canada[1]	3,000	9,000	18,000	34,000	41,000	41,000	43,000	46,000
France[2]	26,000	25,000	30,000	30,000	30,000	30,000	30,000	n/a
USA	24,700	25,000	30,000	28,600	29,600	23,900	18,700	18,500
Norway[3]	8,990	10,595	8,977	8,153	7,655	7,735	8,541	17,991
India	9,451	7,590	10,029	10,000	10,500	11,000	10,000	10,500

Source: Production quantities obtained from the USGS Mineral Yearbooks unless otherwise indicated.

[1] Natural Resources Canada, Mineral Yearbook, 1996 to 2003.

[2] Values are for roofing slates only.

[3] Export quantities listed since production values were not available for review. Actual production quantities would exceed the export values (United Nations Comtrade Database, 1996 to 2003).

[4] A number of other countries, including Portugal, Sweden, and Belgium, are also producing dimension slate in smaller quantities.

In 2003, the top ten slate importers, in decreasing order, were France, United Kingdom, Germany, Poland, United States, Belgium, Canada, Netherlands, Japan, and Spain. (US Comtrade database).

North American production

Slate forms a very small part of the total building stone production in North America. For example, US production of slate in 2003 was 18,500 tonnes or only 1.4 percent of the 1.34 million tonnes building stone total (USGS Minerals Yearbook, 2003). In 2003, Canada produced 46,000 tonnes of shale/slate representing 7 percent of its total building stone production.

Canada

Prior to the 1990s, Canada imported the majority of its' slate construction products. In 2002, the production of slate accounted for 6.4 percent of the total Canadian dimension stone production (Figure 4 and Table A1, Appendix A). The amount of Canadian dimension slate produced between 1996 and 2002 has increased significantly from 3,000 to 46,000 tonnes (Table 5).

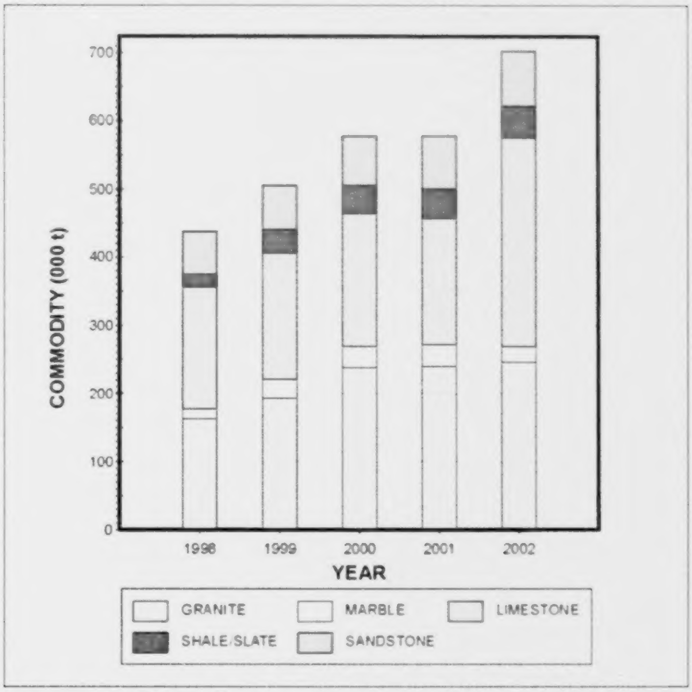


Figure 4 - Canadian production of dimension stone, 1998 to 2002 (Canadian Minerals Yearbook, 1998 to 2002)

Table 5 - Canadian slate industry statistics (tonnes) (Canadian Minerals Yearbook, 1996 to 2003)

	1996	1997	1998	1999	2000	2001	2002	2003
Production	3,000	9,000	18,000	34,000	41,000	43,000	46,000	46,000
Import	3,852	3,412	3,075	2,731	4,298	6,382	8,626	11,548
Export	145	145	173	84	271	357	399	347
Consumption	6,707	12,267	20,902	36,647	45,027	47,025	54,227	57,201

Slate is quarried from five locations in central and eastern Canada as follows:

- The Britannia quarry located in Nut Cove, Trinity Bay, Newfoundland. In 1991, a joint venture was formed between Newfoundland Slate Incorporated and the Miller-McAsphalt Group from Ontario to manufacture roofing slate. A roofing slate plant was constructed at Burgoynes Cove, to process slate from the quarry. In 1994 this was the only operating slate quarry and processing plant in Canada. In 1995 slate production at the plant peaked at 4,700 tonnes. The company quarried both green and purple slate, and processed floor slabs and roof tiles for sale across North America and Europe. The operation closed in 1998. The plant was re-opened again in 2000 by Hurley Slate Works and continues to export slate products around the world. The Britannia quarry remains the only active slate quarry in Newfoundland;

- The Glendyne slate quarry in St. Marc du Lac Long, Quebec was opened in 1995 by Les Carrières Glendyne Inc. The Glendyne quarry is the world's second largest producer of natural slate and plans to increase production from 20,000 to 40,000 tonnes in the next few years (Government of Quebec, 2004). This quarry consists of a bed of dark grey slate which forms a part of the Late Silurian-Early Devonian Temiscouata Formation. The company produces grey roofing slates of which almost all of the production is exported to European and other destinations. The company is also planning to enter the landscaping and slate flooring markets;

- The North Country Slate quarry is located in Scarborough, Ontario. The quarry was discovered during the construction of the Trans-Canada Railway at the turn of the 20th century. North Country Slate is known for producing top-quality unfading black roofing slate. The slate is quarried from an Ordovician deposit using state-of-the art cutting and sorting techniques. North Country Slates' roofing slates are exported worldwide;

- The slate quarry in Hants County, Nova Scotia is operated by Scotia Slate Products Ltd. Quarrying started in the early 1900's but the present operation began in 1995. By 1998 the company had constructed a fabrication facility to produce flooring materials, hearths and mantles, and an array of custom pieces. This quarry produces "a blue-grey to green slate with natural brown, copper, and gold overtones." The material has been exported to landscapers, stone fabricators and stonemasons in Quebec, Ontario, California, New York, Boston and Washington, D.C.; and

- The Silverado slate quarry location near Madoc, Ontario, is operated by the Upper Canada Stone Company. The remains from old slate quarry workings are crushed and processed for use as a decorative landscape stone and as a decorative roofing aggregate.

The amount of slate imported into Canada increased from 1996 to 2003 and continues to rise. The quantity of exported Canadian slate also increased in this period but exports were practically insignificant compared with production and import figures. From Table 5, the Canadian consumption of dimension slate rose from 6,707 tonnes in 1996 to 57,201 tonnes in 2003 (Canadian Minerals Yearbook, 1996 to 2003).

United States

Production and consumption figures for the U.S. dimension stone industry are illustrated in Figure 5. There has been a recent surge in consumption of dimension stone although slate represents only a small fraction of the yearly totals.

Production of dimension slate in the United States has been in decline in recent years (Table 6). The most recent production figure (for 2003) was 18,500 tonnes which was less than was produced at the Canadian Glendyne Quarry alone in that year.

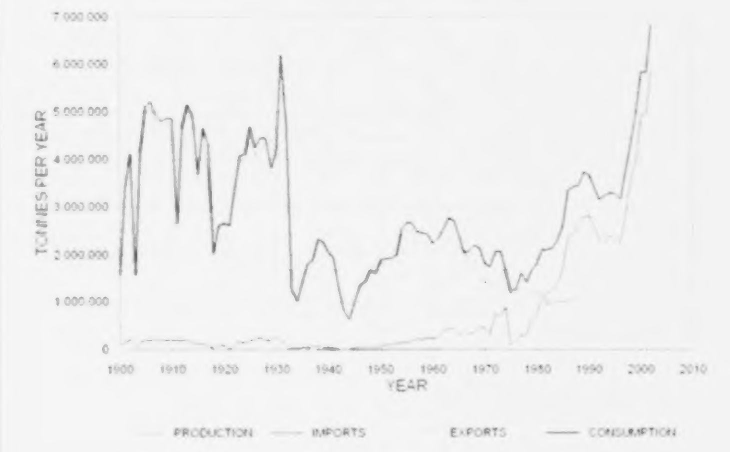


Figure 5 - US dimension stone statistics 1900 to 2002
(DiFrancesco, USGS, Stone (Dimension) Statistics, 2004)

Table 6 - US slate industry statistics (tonnes)

	1996	1997	1998	1999	2000	2001	2002	2003
Production[1]	24,700	25,000	30,000	28,600	29,600	23,900	16,700	18,500
Import[2]	1,709	1,853	3,121	4,539	7,160	9,472	10,583	13,934
Export[2]	1,182	1,551	1,503	1,101	2,085	2,379	1,945	1,252
Consumption	25,227	25,302	31,618	32,038	34,675	30,993	27,338	31,182

[1] USGS Minerals Yearbook, 1996 to 2003.

[2] United Nations Comtrade Database, 1996 to 2003.

The exact number of slate quarries currently in production in the United States are unknown although in 2003 the USGS Minerals Yearbook identified eleven (11) producers operating fifteen (15) quarries. A total of twenty four (24) slate producers and distributors are identified in Table 7 and the key producing regions are presented in Figure 6. The majority of slate produced in the United States comes from two main locations - one near the New York/ Vermont border, and the other at the eastern edge of Pennsylvania.

- The New York/Vermont quarries have been in production for over 150 years. Approximately 400 quarries have been developed within this slate belt over the years, primarily within a 30 kilometre long zone between Fair Haven, VT and Middle Granville, NY. The Vermont quarries are located near Fair Haven, Poultney, Pawlet, Brandon and Sudbury. The New York quarries are located in the Middle Granville area. In both states, flagging, flooring, and roofing slates of all colours are produced.
- Slate has also been in production for over 150 years in eastern Pennsylvania. The current Pennsylvanian slate producers are located within a 40 kilometre zone which includes Pen Argyl, Wind Gap, and Slatington. Architectural, flooring, and roofing slates are produced in this region. They are known for their blue-grey to blue-black or "Pennsylvania Grey"colour.

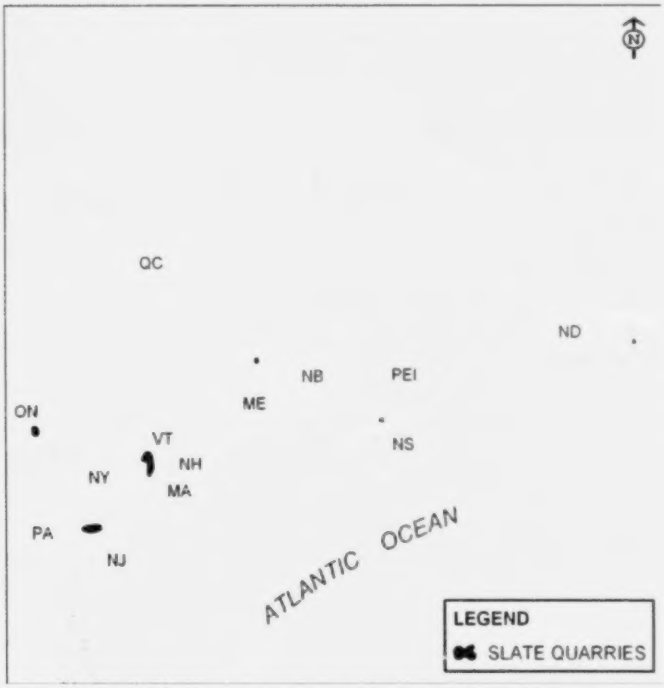


Figure 6 - Locations of major slate producing regions in northeastern North America

Table 7 - List of major slate producers/distributors in northeastern North America

COMPANY	LOCATION	SLATE PRODUCTS
Canada:		
Britannia Quarry	Nut Cove, Trinity Bay, ND	Flooring and roofing
Glendyne Quarry	St. Marc du Lac Long, QC	Roofing
North Country Slate	Scarborough, ON	Roofing
Scotia Slate Products Ltd.	Hants County, NS	Flooring and flagstone
Silverado Slate Quarry	Madoc, ON	Roofing and flagstone
United States:		
Evergreen Slate Co., Inc.	Granville, NY	Flagging, flooring, and roofing
Hilltop slate, Inc.	Middle Granville, NY	Structural, flooring, and roofing
Rising and Nelson Slate Co.	Middle Granville, NY	Flooring and roofing
Tatko Brothers Slate Co., Inc.	Middle Granville, NY	Flagging, flooring, and roofing
Dally and Sons, Inc.	Pen Argyl, PA	Structural, flooring, and roofing
Penn Big Bed Slate Co. Inc.	Slatington, PA	Roofing
Williams and Sons	Wind Gap, PA	Roofing
Baker Slate, Inc.	Pawlet, VT	Roofing
Camara and Sons	Fair Haven, VT	Structural, flagging, flooring, and roofing
Catamount Slate Inc.	Fair Haven, VT	Roofing
Greenstone Slate	Poultney, VT	Roofing
Hadeka Slate Flooring	West Pawlet, VT	Structural, flagging, flooring, and roofing
Maslack Slate Co.	Poultney, VT	Roofing
New England Slate Co.	Sudbury, VT	Roofing
Newmont Slate Co.	West Pawlet, VT	Roofing
Pedro Slate Co., Inc	Fair Haven, VT	Roofing
Plisko Slate Co.	West Pawlet, VT	Roofing
Quarry Slate Industries Inc.	Poultney, VT	Roofing
South Poultney Slate Co.	Poultney, VT	Roofing
Taconic Stone	Fair Haven, VT	Roofing
Taran Brothers Slate Co.	Poultney, VT	Roofing
U.S. Quarried Slate Products, Inc.	Fair Haven, VT	Structural, flagging, flooring, and roofing
Vermont Specialty Slate, Inc.	Brandon, VT	Flooring and roofing
Vermont Structural Slate Co., Inc.	Fair Haven, VT	Structural, flooring, and roofing

The consumption of slate in the United States does not appear to have materially changed in recent years but imports have significantly increased from 1,709 tonnes in 1996 to 13,934 tonnes in 2003 to compensate for the reduced amount of production (Table 6).

The U.S. exports very little slate, but most of this material is destined for Canada (Figure 7) (United Nations Comtrade Database, 1996 to 2003).

The USGS Minerals Yearbooks identify the various uses of dimension slate produced in the U.S. each year (Table A2, Appendix A). The importance of flooring as a use for the U.S. produced dimension slate is evidently increasing.

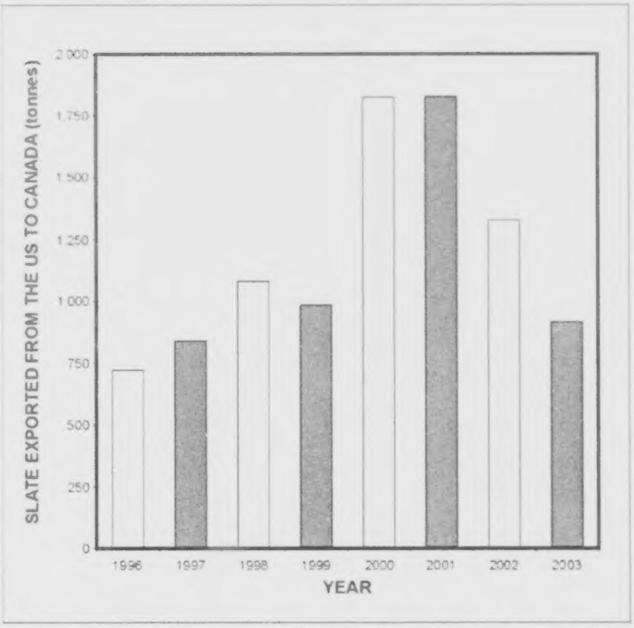
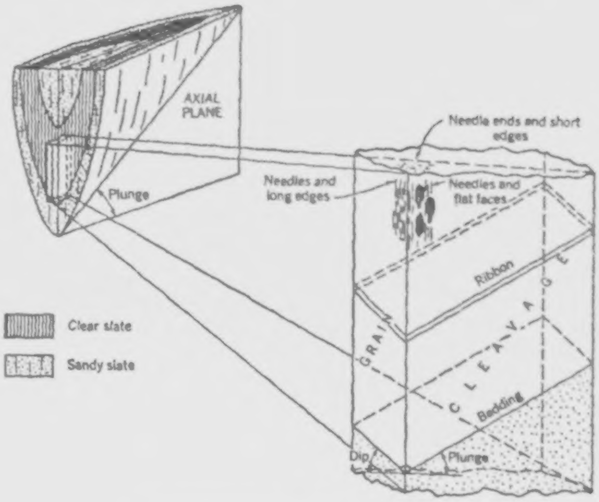


Figure 7 - US exports of dimension slate to Canada 1996 to 2003 (United Nations Comtrade Database, 1996 to 2003)

General geology of slate: Geological controls affecting the distribution and recovery of commercial slate resources

Slate is produced as the result of the intense folding of shale[1]. As such, the stratification of the parent rock is to some degree maintained, but superimposed upon this structure are both slaty cleavage and grain, the latter being attributed to the recrystallization of mineral grains along the cleavage planes. The cleavage planes are orientated perpendicular to direction of maximum compressional stress, while the "grain plane" is a secondary plane of weakness oriented perpendicular to the cleavage (refer to Figure 8). The textural characteristics of the grain can be seen both on the cleavage planes (as needles and flat faces) and on the "grain planes" (as needles and long edges).



The development of cleavage, grain, and ribbon in slate.

Figure 8 - Geologic controls on the quality of a slate resource (Bates, R. L., Geology of the Industrial Rocks and Minerals, Dover Publications Inc., New York, 1969).

The above characteristics have a number of implications on the siting and operation of a potential slate quarry. Firstly, at the limbs of an intense fold, the cleavage and bedding might be expected to be parallel to each other which may result in a good degree of fissility, or at least reduce the likelyhood of the rock breaking into small block sizes when quarried. In such a situation, the bedding and cleavage might be expected to be vertical or subvertical, in which case the approach to quarrying may be governed by the topographic setting. Where the grades are relatively flat, for example in a valley, it would be necessary to develop the deep workings of a "pit quarry." Where the relief is pronounced, for example on a mountain side, it may be more feasible to develop the subhorizontal benches of an "open quarry." The latter would intuitively be an easier proposition to exploit for reasons of access and drainage, but the Glendyne workings in Quebec are relatively deep ones and yet evidently this quarry has been an economic proposition.

Geology of the study area:

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[1] Since the typical slate minerals are not those associated with great heat, an environment of strong directed pressure is inferred.

Previous work

Available geologic information was reviewed for the purpose of evaluating the slate resource potential in the study area. Early regional geological mapping of the region was conducted by Nylander (1940) and Alcock (1941). In 1961, Jones carried out a survey to the north and west of Edmundston. Following these studies, Poole (1964) summarised the geology of the region.

In 1977, St. Peter, undertook a detailed geologic mapping project in parts of Restigouche, Victoria and Madawaska counties. More recently, Carroll (2003) conducted geological investigations in the eastern half of the study area. This involved a comprehensive study of the geologic history and an assessment of the region's mineral/hydrocarbon resource potential. Additional data reviewed were the geology of the Squatec - Cabano area (Lesperance, 1969) and information from the State of Maine Digital Geology Imagery (State of Maine, 2004).

A compilation map showing the bedrock geology is shown in Figure 9 and in the Map Plate (in the back pocket).

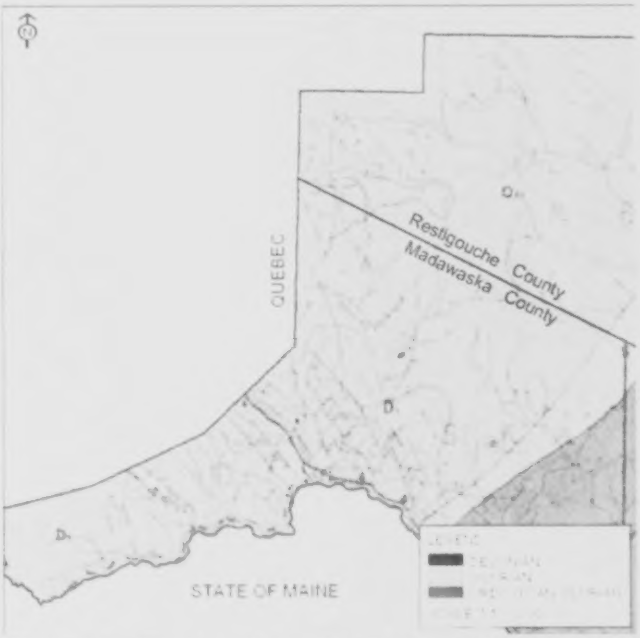

Figure 9 - Regional geology of northwestern New Brunswick (Potter, R.R., Hamilton, J.B., and Davies, J.L., Geology Map N.R.-1, New Brunswick Department of Natural Resources, Second Edition, 1979)

Physiography

The study area is bounded to the southwest by the St. John River and to the northeast by the Restigouche, Kedgwick and Patapedia Rivers. These rivers, together with the Madawaska, Green and Grand rivers to the southwest form the main drainage system of the area.

A thin cover of glacial till is commonly seen throughout the area. The river valleys have abundant glacial outwash of sand and gravel. The area has mixed dense forest cover. Rock exposures are limited to river, stream and logging road sections.

Detailed geology

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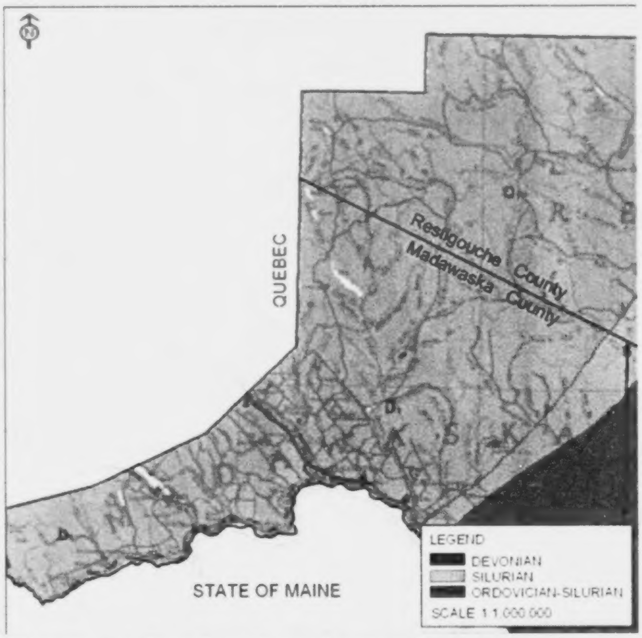

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Detailed geology

St. Peter (1977) and Carroll (2003) mapped all or part of the following 1:50,000 scale NTS map sheets:

- Connors (NTS 21 N/02);
- Lac Baker (NTS 21 N/07);
- Edmundston (NTS 21 N/08);
- Grand Maison (NTS 21 N/09);
- Wild Goose Lake (NTS 21 N/16);
- Gounamitz River (NTS 21 O/12); and
- States Brook (NTS 21 O/13).

From this work, the rock formations in the region are described as comprising an assemblage of siliciclastic and calcareous rocks typical of an outer shelf - slope depositional environment (Late Ordovician to Middle Devonian). These rocks constitute part of the Gaspé tectono-stratigraphc belt that extends from northern Maine through northwestern New Brunswick to the eastern tip of the Gaspé Peninsula in Quebec.

The study region comprises five lithostratigraphic units: (1) the Late Ordovician, Grog Brook Group; (2) the Late Ordovician to Early Silurian Matapedia Group; (3) the Early to Late Silurian, Perham Group; (4) the Early Devonian, Fortin Group; and (5) the Early to Middle Devonian, Gaspé Sandstones Group (Table 8).

Table 8 - Proposed lithostratigraphic succession for the study area (after Carroll, 2003)

AGE	LITHOSTRATIGRAPHIC UNIT	LITHOLOGIC DESCRIPTION
EARLY DEVONIAN	GASPÉ SANDSTONE GROUP	Argillaceous limestone, sandstone and shale
	FORTIN GROUP Temiscouta Formation Tracy Brook Formation	Calcareous siltstone and sandstone Calcareous sandstone and siltstone
EARLY-LATE SILURIAN	PERHAM GROUP Gounamitz Lake Formation	Calcareous, siliceous sandstone and red shale
	CHALEURS GROUP Upsalquitch Formation	Calcareous sandstone and siltstone
LATE ORDOVICIAN-EARLY SILURIAN	MATAPEDIA GROUP White Head Formation Pabos Formation	Limestone, calcareous shale Calcareous sandstone, shale and limestone
LATE ORDOVICIAN	GROG BROOK GROUP Whites Brook Formation Boland Brook Formation	Sandstone and non-calcareous shale Non-calcareous siltstone, shale and minor sandstone

For the purpose of this study, slate investigations were focused on the sedimentary clastic rocks of the Fortin Group.

The Fortin Group underlies all of the central and western parts of the States Brook and Gounamitz River map-areas respectively and extends southwest to the Baker Lake area near Edmundston (Figure 1). The group consists of medium to fine-grained clastic rocks of the Tracy Brook Formation overlain conformably by the calcareous, fine to medium-grained clastic rocks of the Temiscouta Formation.

The Temiscouta Formation in the study area is comprised of two members. The lower and most abundant member is composed of a thick assemblage of thin-to locally medium-bedded, light green, grey, dark grey to black, micaceous, weakly to noncalcareous slate and siltstone. These rocks are interbedded and locally intercalated with dark grey to medium-bedded micaceous sandstone. Minor 1 to 3 m thick beds of polymictic pebble conglomerate occur, located mainly in the western part of the States Brook map-area. Rocks of the slate-siltstone unit display light greyish brown to medium grey weathering, whereas the interbedded sandstone is typically tan in colour. The sandstone is generally fine-grained and thin-bedded (1 - 5 cm). Medium-to coarse-grained wacke and arkosic beds do occur locally in the central part of the States Brook map-sheet. Coarse grained sandstone beds are ubiquitous throughout the clastic sequence, accounting for approximately 30 to 50 per cent of this lower member of the formation, with the balance being slate-siltstone that generally displays a moderate to well-developed cleavage. The upper contact of the slate-siltstone-sandstone unit is conformable and gradational over a minimum distance of about 500 m with the overlying calcareous member of the Temiscouta Formation.

The upper calcareous member of the Temiscouta Formation consists of thin-bedded (1-10 cm), dark grey to bluish grey to black, micaceous and strongly calcareous siltstone and slate. These are interbedded with medium grey to dark grey, highly calcareous, fine-grained, thin-bedded and parallel-laminated sandstone and shale. Their strongly calcareous nature would likely affect the long term durability when exposed to the elements, and for this reason the rocks of this member are not considered as a potential slate resource.

According to Bourque et. al. (1995) and Van Staal and de Roo (1995), the study region has undergone a middle to late Silurian (Salinic) sturctural event that produced a series of minor northwesterly trending open folds and local syn-sedimentary faulting. This was followed by a second deformation associated with Middle Devonian Acadian Orogeny that generated open to locally tight, northeasterly trending, doubly plunging folds accompanied by contemporaneous dextral strike slip faulting. In the case of Temiscouta Formation, the mudrocks have absorbed much of the strain of the deformation as indicated by the presence of tight upright folds which resulted in the formation of moderate to well developed cleavage. The cleavage, in general, strikes northeast with steep dips towards northwest and southeast.

Three major fault zones are recognized in the study area (Map Plate 2005-xx). These structures are interpreted to have had complex movement histories and are responsible for the current distribution of the lithological units (Carroll, 2003):

- the McKenzie Gulch Fault juxtaposes the rocks of the Grog Brook against those of the Chaleur Bay Group;
- the Restigouche-Lower Downs Gulch Fault zone juxtaposes rocks of Fortin Group against the older sequences of the Perham, Matapedia and Grog Brook groups (Aroostook-Perce Anticlinorium). This fault is believed to have had considerable dextral strike-slip displacement; and
- the Sainte-Florence Fault in the northwestern part of the States Brook map-sheet, juxtaposes rocks of Fortin Group and those of the Gaspé Sandstone to the northwest.

Dykes and sills of felsic and mafic composition are emplaced near faults and shear zones associated with the regional Restigouche-Lower Downs Gulch Fault System. In the States Brook map sheet these dykes are northwesterly trending. However, in the Gounamitz River map-sheet, dykes are randomly oriented and tend to follow regional structural and stratigraphic trends.

Field and laboratory investigations:

Field reconnaissance and sample site selection

A field reconnaissance of potential slate and slate-like materials was undertaken in the proposed study area. Given the scope and preliminary nature of this investigation, reconnaissance activities were restricted to: (a) favourable areas identified from available geologic maps; (b) Crown land; (c) favourable settings where rock outcrops might reasonably be expected to occur (e.g. highway road cuts, cliff faces, stream sections); and (d) areas of practical access (e.g. adjacent paved roads, Class I and II woods roads).

To complement this approach, a GIS project with a number of digital themes was prepared. Themes included topography (the digital terrain model [or DTM] from which contours were generated), roads, streams; Crown land, bedrock geology, and associated rock outcrop.

It had been intended that a simple rating system be developed based on a score generated for each of the relevant themes. In practice however, target areas for reconnaissance became fairly evident from examination of the GIS compilation map.

In mid-October (2004), geotechnical and related data were gathered from thirty seven (37) selected occurrences of slate or slate-like material in the study area. Twenty nine (29) sites were chosen from the western part of Restigouche County with the balance (8) being situated in the western part of Madawaska County.

Rock exposures at each selected site were systematically described in terms of mineralogy and textural and structural features. Field observations were recorded on data sheets detailing:

- site number;
- location (NTS map sheet number, coordinates, geographic location);
- site description (exposure type, vegetation, terrain);
- rock description (geologic formation/unit, lithology, colour as per the Munsell colour chart, texture, and deleterious materials);
- structural features (folds, faults, bedding and cleavage planes, block sizes and classification, fissility); and
- general observations.

Field observation data sheets complete with illustrative photographs are presented in Appendix B. Representative rock samples were also collected from most sites.

The findings of the reconnaissance part of this site investigation are now briefly summarized for each NTS map sheet within the study area:

States Brook, NTS map sheet 21 O/13

Of the 37 sites visited in the course of reconnaissance, seventeen (17) were located within the States Brook map sheet (21 O/13) in the northeastern part of the study area (Figure 11, Map Plate 2005-xx). Most of these sites are adjacent to the Rapids Depot forest access road, a northwesterly trending unpaved Class I forest road near the southwestern corner of the map sheet. Rock exposures observed in this area are mainly indurated shales, generally with subvertical cleavage. The cleavage strikes northeast-southwest, in a direction similar to that of the regional structural trend[2]. The bedding is generally flat-lying but the strike is variable. Bedding joints are not highly developed and the rock is not excessively broken as a result.

One of the most notable rock exposures observed on this map sheet was at Site 18 located beside the Camp 69 Road a few kilometres south of the Rapids Depot access road (Figure 11, Map Plate 2005-xx). The slate material here is not sufficiently strong nor fissile to meet roofing slate specifications, but it might be of some use in landscaping applications (Figure 10).

More highly fissile rock was observed at Site 28 (near the eastern end of States Lake) and at Site 31 to the southeast, but at these locations the rock was considered to be of even poorer quality material.

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[2] Where not vertical, the dip tends to be slightly to the northwest.

More massive, better quality rock was observed at Site 27 adjacent to the States Lake road, just north of its intersection with the Rapids Depot access road.

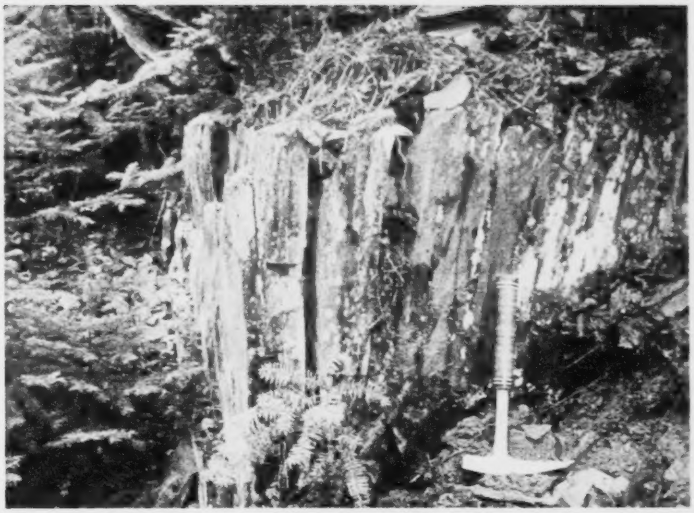


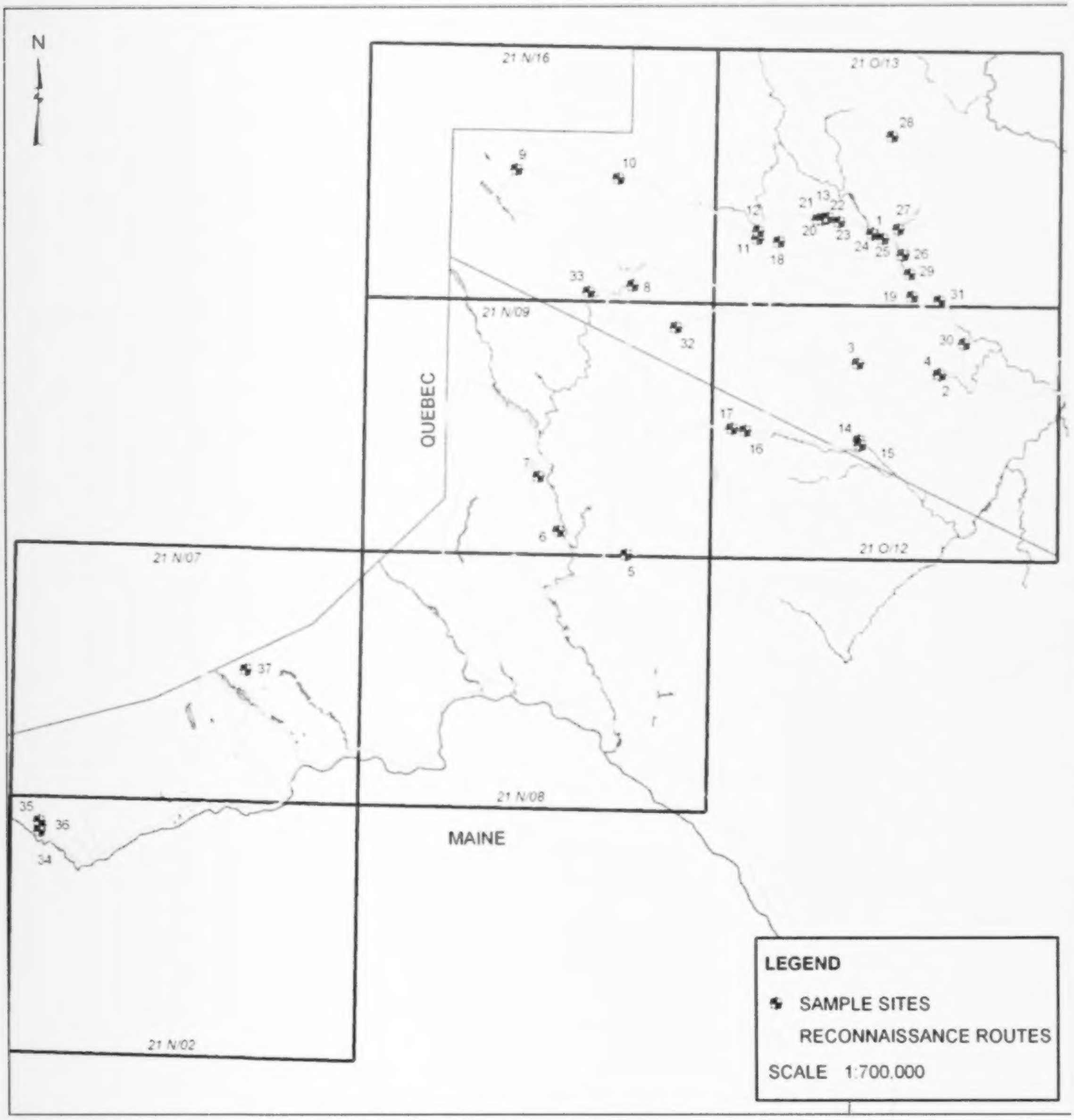
Figure 10 - Slate exposure at Site 18. Subvertical cleavage evident, but the rock is not very fissile

*Gounamitz River, NTS map sheet 21 O/*12

Eight (8) sites were examined on the Gounamitz River map sheet (21 O/12). Rock exposures of interest were observed in a number of areas as follows:

- adjacent to the Rapids Depot Road some 3 km north of its intersection with the Falls Brook Road (Site 30 in Figure 11 and Map Plate 2005-xx);
- adjacent the Falls Brook Road, some 3 km west of its intersection with the Rapids Depot Road (Sites 2, 3 and 4); and
- beside another woods road, further south near the Madawaska-Restigouche county line (Sites 14, 15, 16 and 17).

In general the rock exposed at these sites comprises indurated shales and slates, displaying a subvertical cleavage striking southwest - northeast. The bedding is variable in strike but generally fairly flat-lying.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LEGEND
SAMPLE SITES
RECONNAISSANCE ROUTES
SCALE 1:700,000

Figure 11 - Location of selected slate sample sites in the study area

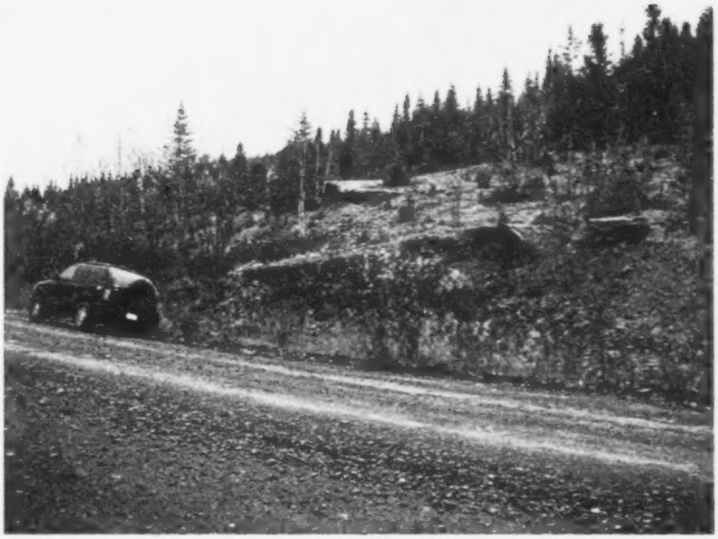

Figure 12 - Slate exposure at Site 17. Rock at this location was of the best observed quality

Of the rock exposures examined within this map sheet, that at Site 17 located on the above "County line" road to the west is arguably of the best quality observed (refer to Figure 12).

Another somewhat promising location was Site 2 located alongside the Falls Brook Road just to the west of its intersection with the Rapid Depot Road.

Both of these sites (i.e. 17 and 2) may provide a source of slabs suited for use in a variety of landscaping applications.

Wild Goose Lake, NTS map sheet 21 N/16

Four (4) sites were located within the Wild Goose Lake map sheet in the northwest part of the study area (Sites 8, 9, 10 and 33 in Figure 11), an area of "non-calcareous slate and argillite" of the Lower Devonian Temiscouta Formation (C. St. Peter). The rock quality at all noted locations was considered poor, characterized by unfavourable jointing and poor fissility.

Mapping (R. A. Jones, 1961) indicates a narrow, southwest-northeast trending band of black slate and shale intermixed with argillite crossing the map sheet between Sites 9 and 10, parallel to the regional structural trend. Although no outcrops of this slate unit were identified during this preliminary reconnaissance, further investigation may be warranted. The mapped unit is broadly on strike with an active slate mining and processing facility operated by Glendyne Inc. (Figure 13) and located some 65 kilometres to the southwest near St. Marc du Lac Long within the Province of Quebec.

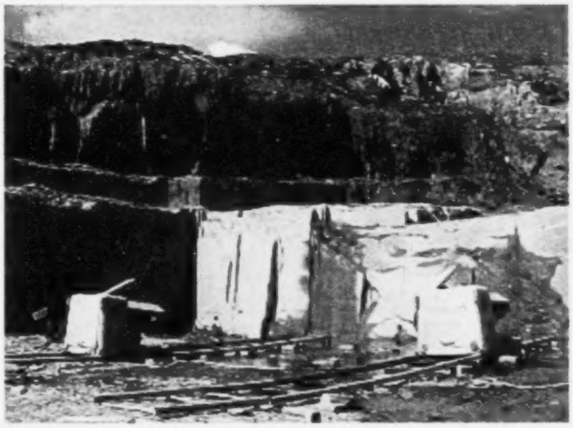

Figure 13 - View of the Glendyne Quarry at St. Marc du Lac Long, PQ

Grand Maison, NTS map sheet 21 N/09

Four (4) sites were selected within the Grand Maison map sheet (21 N/09) (Sites 5, 6, 7 and 32), where bedrock of the Lower Devonian Temiscouta formation was again encountered (C. St. Peter). Rock quality was considered to be the poorest observed in the northern part of the study area. At Site 7, the very close joint spacing has resulted in pencil slate development (Figure 14).

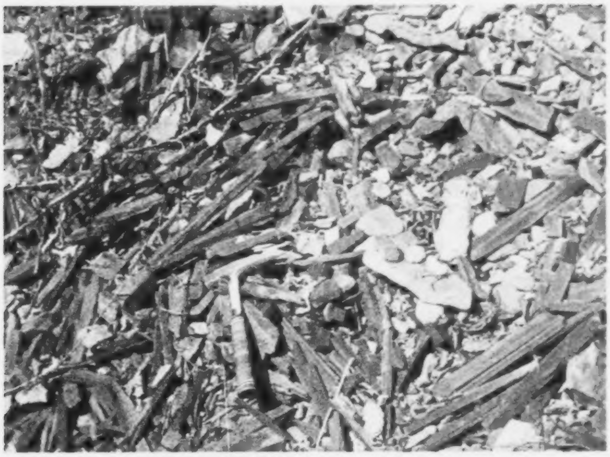

Figure 14 - Pencil slate development evident at Site 7

Connors, NTS map sheet 21 N/02, Lac Baker (NTS 21N/07), and Edmundston (NTS 21N/08)

Only limited tracts of Crown land occur within the Connors, Lac Baker and Edmundston map sheets (NTS map sheets 21 N/02, 21 N/07 and 21 N/08 respectively), and access to such lands is generally limited. As a result only four (4) sites were noted in this part of the study area (Sites 34, 35, 36 and 37 including one [Site 36] which was actually on freehold property, Figure 11). Rock exposed at these sites is characterized as non-calcareous argillite and slate of the Lower Devonian (Temiscouata Formation). The observed rock was typically flat-lying with poorly developed joints, and as a result is not considered well suited for most natural stone applications.

Evaluation of physical and mechanical properties of selected samples

As a means of comparing the observed rock with established quality standards and with the characteristics of typical slate products currently available in the market place, representative samples were subjected to various physical, mechanical and chemical tests.

Although attempts were made to sample as "fresh" a material as possible, it must be recognized that most samples were collected from either natural rock outcrops or from rock cuts exposed beside access roads. Varying degrees of physical and chemical weathering, coupled with the structural impact of adjacent road construction, will have adversely affected rock quality. The physical and mechanical test data presented here may therefore not accurately reflect the true nature of the resource, but rather serve as a minimum standard. Better quality material might be expected at depth.

Absorption

Eighteen samples (18) were tested for water absorption as per Water Absorption of Slate, ASTM C121-90). The results, summarized in Table C1, Appendix C, ranged from 0.51 to 4.09 percent (Figure 15). These values were all above the maximum desirable figures quoted in the literature[3]. The three most indurated samples with the lowest absorption values were from sites 17 (0.51%), 27 (0.89%) and 3 (1.00%).

By way of comparison, promotional literature from three active slate operations report absorptions of 0.19% (Scotia Slate Products Ltd., Nova Scotia), between 0.08 and 0.25% (Sheldon Slate Products, Maine and New York State), and 0.22% (Everlast Slate, China). Low water absorption is obviously a requirement for enduring service life, but given the limited sampling undertaken thus far in the study area it would be premature to rule out the possibility that durable slates meeting apparent industry standards for water absorption are present at depth within the study area.

Point load

To give some idea of rock strength, fourteen (14) samples were subjected to point load testing as per the Point Load Strength Index of Rock, ASTM D5731-95. The testing protocol and detailed test results are presented in Table C2, Appendix C. The data are summarized graphically in Figure 15. From the point load test data the relative strength of the various samples was as shown in Table 9:

Table 9 - Relative strength of various rock samples, by site number

WEAKEST	INTERMEDIATE STRENGTH	STRONGEST
18 21 23 28 31	3 4 10 11 30	17 19 24 27

Flexural strength

Two (2) samples (Sites 4 and 17) were subjected to flexural strength testing as per the Modulus of Elasticity and Rupture of Slate (ASTM C120-00)[4]. The results are reported in Appendix C3 and are summarized in Table 10.

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[3] 0.25 percent for exterior use and 0.45 percent for interior use (ASTM C121-90).

[4] These tests were conducted by Bodycote Materials Testing of Mississauga, Ontario.

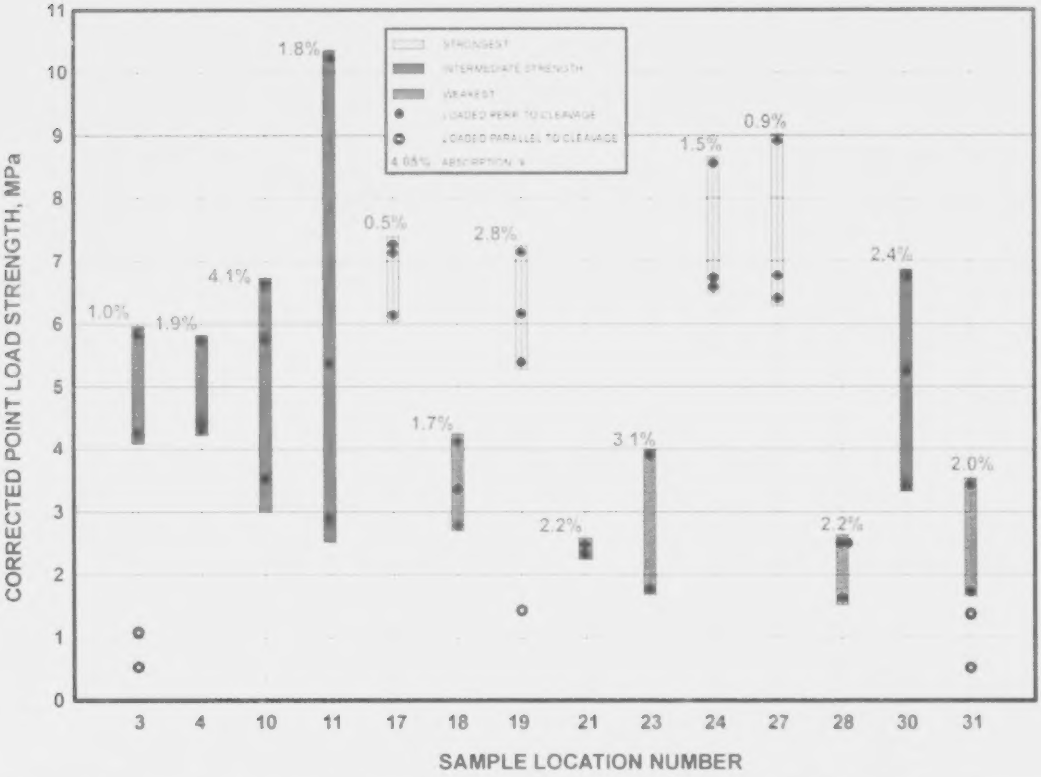

Figure 15 - Point load and absorption data for selected slate samples recovered from selected sites in northwestern New Brunswick. (Note the weak correlation between point load strength and absorption, with the absorption of the strongest rocks being somewhat lower than that of the weakest ones).

Table 10 - Flexural strength test data for five slate samples recovered from the study area in northwestern New Brunswick (ASTM C120-00)

SITE	SAMPLE	MODULUS OF RUPTURE (MPa)	MODULUS OF ELASTICITY (MPa)
4	A	N/A	N/A
	B	N/A	N/A
	C	15.97	6160
17	A	30.4	1767
	B	43.15	19740

By way of comparison, product information from the three active slate operations noted earlier indicates modulii of rupture of 53.6 MPa (Scotia Slate Products Ltd., Nova Scotia), between 67.0 and 104.6 MPa (Sheldon Slate Products, Maine and New York State), and 57.6 MPa (Everlast Slate, China). The flexural strength values of the tested slates from northwestern New Brunswick were lower than those from the operations noted above, but as with the absorption data, given the nature of the samples, and the very limited scope of sampling and testing, it would be premature to rule out the possibility that appropriately durable slates are present at depth within the study area.

Evaluation of chemical and mineralogical properties of selected samples

Chemical analysis

Two samples (Sites 17 and 24) were selected for whole rock analysis, wherein major and minor elements were quantified[5].

The results are presented in Table C4 (Appendix C) and are summarized in Table 11, along with geochemical data from two regional slate operations. The New Brunswick data are also plotted graphically (Herron, 1988) in Figure 16 on which basis both samples would be classified as shales from a geochemical viewpoint. Materials from a slate operation in Nova Scotia are evidently less siliceous, while those from an operation in China are more siliceous.

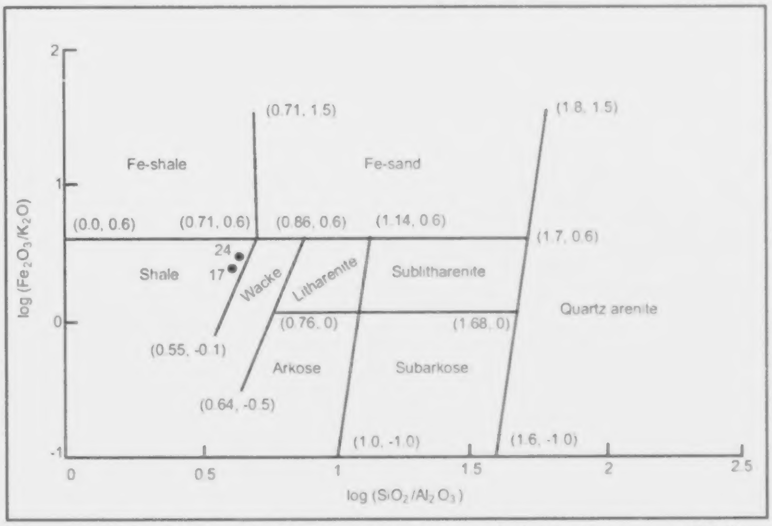

Figure 16 - Chemical classification (after Herron, 1988)

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[5] The term "whole rock" is used to distinguish the chemistry of the rock as a whole from the analysis of its mineral components. The analysis was performed by Activation Laboratories Ltd. in Ancaster, Ontario.

Table 11 - Comparison of whole rock chemistry for selected slate samples from northwestern New Brunswick with existing slate producers (See Figure 11 and Map Plate 2005-xx for locations)

Sample	Al2O3	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O	P2O5	SiO2	TiO2	LOI	Total
Site 17, New Bruncwick	15.41	1.31	0.02	6.92	2.68	2.98	0.08	1.99	0.17	63.44	0.88	4.33	100.2
Site 24, New Brunswick	14.85	0.41	0.02	6.41	2.61	2.42	0.07	2.1	0.19	67.06	0.91	3.29	100.3
Scotia Slate (blue), NS	24.39	0.23		6.52	4.53	0.96	1.5	1.46		54.15	1.07		
Scotia Slate (green), NS	23.82	0.2		9.2	3.17	2.75	0.73	1.11		55.42	1.06		
Everlast Slate (Vermont)	12.83	0.32		2.48	2.9	2	0.16	1.64		70.08	1.14	2.5	

Figure 16 also reveals that the selected New Brunswick slate samples plot near the highly ferruginous field of the diagram. It is further noticed that these samples also show higher values of loss on ignition (LOI), and lower Al_2O_3, K_2O and SiO_2 contents than observed in the case of slate samples from Nova Scotia. Higher LOI values most probably reflect the higher carbonate content. Lower values of Al_2O_3 and K_2O could possibly reflect the lower concentrations of clay minerals, in particular, potassium-bearing clay minerals. Higher silica together with lower proportions of clay minerals may result in a more brittle slate material.

Although the samples from New Brunswick were chemically different than the ones from Nova Scotia, the whole rock chemistries were somewhat similar to those for the (Everlast Slate) sample from Vermont. The latter is evidently a marketable roofing slate product.

Petrography

Samples 17 and 24 were also petrographically examined for major mineralogical assemblages, and are described as follows:

Site 17 Minerals present include quartz, feldspars (plagioclase and K-spar), chlorite, opaques, and sphene. The rocks are too fine-grained to permit quantitative estimates of various minerals. Refer to Figure 17 and the summary form in Appendix E.

Alternating layers displaying grain size variation of the mineral constituents of the rock defines the bedding. It appears that the coarser beds seem to contain a higher percentage of quartzofelspathic minerals. The overall range of grain size in the rock is 0.015 - 0.042 mm.

Clastic grains of quartz, feldspars and chlorite, constituting about 30 percent of the rock, occur in a clay and / or silty matrix. The matrix is transformed into microcrystalline micas and clay minerals during compaction and diagenetic recrystallization. Although most of the micaceous material is oriented parallel/subparallel to the cleavage, some of this material is randomly oriented. The cleavage planes intersect the bedding surfaces at a small angle of about 15 degrees.

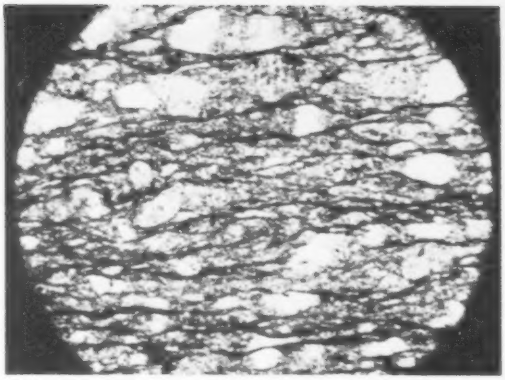


Figure 17 - Photomicrograph of sample 17 under plane polarized light (x 100, showing cleavage with clear quartz and altered feldspar).

The clasts generally display subangular to subrounded shapes. Most of the clasts show varying degrees of flattening and elongation parallel/ subparallel to the cleavage. Feldspar clasts are variably altered to mica and clay minerals. Higher proportions of micaceous and clay minerals indicate that the feldspar content was higher than that of quartz.

Although no obvious carbonate minerals could be identified in the rock, hairline fractures (0.02 to 0.05 mm wide) containing calcium carbonate are noted. These fractures are parallel/subparallel to the cleavage.

Site 24 Constituents present include quartz, feldspars (plagioclase and K-spar), chlorite, matrix, opaques, sphene, and tourmaline (Figure 18 and Appendix E).

Alternating layers displaying grain size variation of the mineral constituents of the rock defines the bedding. It appears that the coarser beds seem to contain a higher percentage of quartzofelspathic minerals. The range of the grain size is 0.02 - 0.45 mm.

Irregular to subrounded clastic grains of quartz, feldspars and chlorite are embedded in a microcrystalline micaceous silty/clay matrix. The matrix has

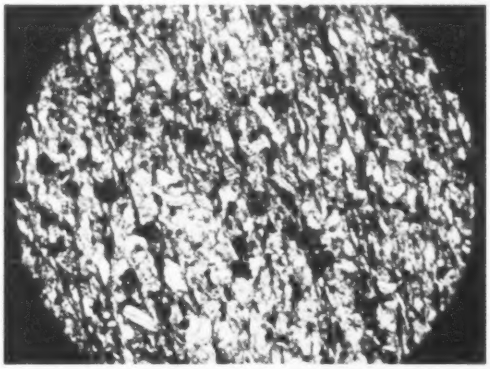


Figure 18 - Photomicrograph of sample 24 under plane polarized light (x 100, showing cleavage with clear quartz and altered feldspar).

undergone compaction and diagenetic recrystallization. Tiny flakes of sericite, muscovite and chlorite (?) with ragged boundaries lie parallel/subparallel to the cleavage surfaces. However, a small percentage of the micas occur in random orientation. The cleavage planes intersect the bedding surfaces at an angle of about 40 degrees.

Tiny (0.1 - 0.02 mm in diameter) grains of sphene with a rind of brown iron oxide occur randomly distributed throughout the rock.

The feldspars are variably altered to clay minerals and micas. A few grains of unaltered plagioclase display albite twinning. The amount of micaceous and clay minerals suggest that the rock contains a higher proportion of feldspars in comparison to quartz.

Discontinuous hairline fractures (0.01 - 0.02 mm wide) containing calcium carbonate occur parallel/subparallel to the cleavage. A few grains of tiny (0.01 mm in diameter) euhedral grains of tourmaline are noted.

Assessing the development potential for slate and slate-like materials from Crown land in northwestern New Brunswick:

In this study, slate and slate-like materials from selected Crown Land sites have been classified and rated with respect to their development potential for a wide variety of applications. Rock quality factors such as durability, jointing, fissility and mineralogy will determine potential product lines. These factors are considered along with several logistical ones that could affect operational strategies and the economics of a proposed development.

Explanation of development parameters and priority rating system for selected slate resource sites

The rating system developed to permit comparison of the observed rock exposures from selected sites is based on a “Site Rating Number” (SRN) which is the product of a "Rock Quality Factor" (RQF) and a "Site Development Factor" (SDF).

The Rock Quality Factor (RQF) is the sum of four parameters, with the value of each determined as follows:

> ***Durability (D):*** Durability is evaluated on a scale of 0 to 3. It is a subjective measure of the ability of a slate or slate-like rock to remain intact under the combined effects of physical, mechanical and chemical stress. A value of zero is assigned to rock of very low intact strength and high absorption, or with chemical or mineralogical features suggesting that rapid degradation might occur under normal weathering conditions. A value of 2 is assigned to rock of intermediate intact

strength and absorption which appears to be free and clear of potentially deleterious minerals. A value of 3 is assigned to rock of relatively high intact strength and low absorption, approaching or exceeding the strength and absorption criteria for standard roofing slate material.

Jointing (J): Jointing is classified on a scale of 0 to 8. It is a subjective measure of the degree to which secondary joints might adversely affect the breaking characteristics of the rock mass. In this context, secondary joints would be those fractures other than the joint set responsible for breakage into thin slabs or plates. A value of zero is assigned to a rock mass which is closely jointed with respect to these other orientations (on a scale of 30 cm or less), resulting in either very low block volume or in blocks of non planar or very irregular shape. A value of 8 would be assigned to relatively massive rock where the cleavage is the most dominant structural feature and where orthogonal joint sets, if present, would not likely interfere with the production of slabs on the scale of a metre or so in dimension. It should be noted that such massive rock would not in itself be suitable for marketable applications unless it was also adequately fissile. Values of 2, 4 or 6 are assigned to rock of intermediate fracture characteristics, depending on the perceived difficulty or ease with which the rock mass might be broken into slabs or plates of marketable dimension.

Fissility (F): On a scale of 0 to 8, a value of "0" is assigned to rock that does not readily split into flat plates of variable thickness, while rock that splits easily would be assigned a value of "6" or above. Note that rock that is fissile but because of multiple jointing or low intact strength splits into pencils or other non plate-like pieces would be assigned a low not high number. Values of 2, 4, or 6 are assigned to rock of intermediate fissility, depending on the difficulty or ease with which the rock mass might be broken along the cleavage into slabs or plates of marketable dimension.

Mineralogy (M): The potential effect of mineralogy on the suitability of the slate or slate-like rock in various applications is assessed on a highly subjective scale of 0 to 3, where low numbers are given in those cases where pyrite, carbonate or other potentially deleterious constituents are present and a higher number is assigned where such minerals are not present.

The sum of the four RQF parameters (maximum 22) is then prorated to a base value of "10" (by multiplying by 10/22 [or 0.45]) to arrive at the Rock Quality Factor.

The Site Development Factor (SDF) is the sum of three parameters with the value of each determined as follows:

Development Potential (P): The perceived difficulty or ease with which the observed rock exposure or its environs might be developed into a working quarry is assessed on a subjective scale of 0 to 4, although it should be noted that constraints such as unfavourable terrain can be countered. On this scale, "0" is assigned to non-Crown land; "1" or "2" is assigned where poor relief might limit development of a quarry; and "3" or "4" is applied to those other cases where there are no obvious topographic or other constraints on development.

Environmental Factor (E): Each site is subjectively rated on a scale of 0 to 4, according to the perceived presence or absence of features of potential environmental significance that might affect development. Such features might include a nearby watercourse, or the presence of nearby camps or houses.

Distance/Access (A): This factor, rated on a scale of 0 to 2, is prorated from zero (most distant from Edmundston) to "2" (closest to the municipality).

The sum of the three SDF parameters (i.e. P + E + A) (maximum 10) becomes the Site Development Factor.

The overall "Site Rating Number" (SRN) is therefore the product of the RQF and SDF:

$$\mathrm{SRN} = \mathrm{RQF} \times \mathrm{SDF} = [(D + J + F + M) \times 0.45] \times (P + E + A)$$

Since the above rating system is both highly subjective and somewhat arbitrary the results should not be over-interpreted. Some of the constituent parameters may be in conflict with each other (for example highly fissile rock may have these properties because the intact strength is low). Other elements may combine to unfairly discriminate against otherwise fair quality rock (e.g. an outcrop near a stream may be assigned poor SDF marks by virtue of being in a valley, therefore awkward to quarry, but also for "environmental" concerns).

Discussion of slate resource site rating results

Notwithstanding the obvious limitations of the rating system, the SRN and particularly the RQF values were used to rate and categorize each of the 37 sites considered during this preliminary investigation of slate and slate-like materials. The sites were divided into one of three broad groups, with the development potential qualified as good, fair and poor. The results of this assessment are presented in Table 12 and are summarized in Table 13.

TABLE 12 - Summary of rated development potential for selected slate and slate-like material sites in northwestern New Brunswick

(refer to Figure 11 and Map Plate 2005-xx for location)

SITE #	LATITUDE	LONGITUDE	NTS MAP SHEET	RATING				ROCK QUALITY FACTOR[1] (RQF)	DEVELOPMENT POTENTIAL (P)	ENVIRONMENTAL CONSTRAINTS (E)	DISTANCE AND ACCESS (A)	SITE DEVELOPMENT FACTOR[2] (SDF)	SITE RATING NUMBER (SRN)	RATED BY ROCK QUALITY[3]	RATED PRIORITY (37 max)
				DURABILITY 0 to 3 (D)	JOINTING 0 to 8 (J)	FISSILITY 0 to 8 (F)	MINERALOGY 0 to 3 (M)								
1	47 49 13.8	67 46 16.8	21 O/13	2	6	4	2	6.4	4	1	0.4	5.4	35	fair	13
2	47 40 59.4	67 40 16.8	21 O/12	2	6	6	2	7.3	4	2	0.5	6.5	47	good	4
3	47 41 34.0	67 47 26.9	21 O/12	3	2	4	2	5.0	4	2	0.3	6.3	31	poor	20
4	47 40 59.2	67 40 24.6	21 O/12	2	4	6	1	5.9	3	2	0.5	5.5	32	poor	18
5	47 30 04.0	68 07 14.6	21 N/09	2	2	6	2	5.5	3	3	1.8	7.8	42	poor	6
6	47 31 23.7	68 13 05.4	21 N/09	2	2	4	2	4.5	2	1	1.8	4.8	22	poor	34
7	47 34 35.8	68 14 55.3	21 N/09	1	2	2	3	3.6	2	3	1.6	6.6	24	poor	30
8	47 45 58.0	68 07 03.6	21 N/16	2	4	2	1	4.1	4	2	1.3	7.3	30	poor	23
9	47 52 40.9	68 17 21.8	21 N/16	1	2	2	2	3.2	3	3	0.7	6.7	21	poor	35
10	47 52 15.2	68 08 27.4	21 N/16	2	2	6	2	5.5	2	3	0.5	5.5	30	poor	22
11	47 48 49.9	67 56 17.9	21 O/13	2	2	4	3	5.0	4	2	0.6	6.6	33	poor	17
12	47 49 16.8	67 56 13.3	21 O/13	2	2	4	3	5.0	4	2	0.6	6.6	33	poor	15
13	47 50 04.9	67 50 39.6	21 O/13	2	2	2	2	3.6	4	2	0.6	6.6	24	poor	31
14	47 37 02.0	67 47 17.0	21 O/12	1	2	4	2	4.1	3	2	1.0	6.0	25	poor	28
15	47 36 47.1	67 47 08.8	21 O/12	1	2	6	2	5.0	3	2	1.0	6.0	30	poor	21
16	47 37 30.3	67 57 05.5	21 O/12	3	6	2	3	6.4	4	2	1.3	7.3	46	fair	5
17	47 37 38.0	67 58 14.1	21 O/12	3	8	6	2	8.6	4	2	1.3	7.3	63	good	1
18	47 48 42.0	67 54 26.1	21 O/13	2	6	6	2	7.3	4	3	0.7	7.7	56	good	2
19	47 45 33.3	67 42 47.2	21 O/13	2	4	4	2	5.5	2	2	0.3	4.3	23	poor	32
20	47 50 02.5	67 51 05.2	21 O/13	2	4	6	2	6.4	4	2	0.6	6.6	42	fair	7
21	47 50 02.5	67 50 42.7	21 O/13	1	4	4	2	5.0	4	2	0.6	6.6	33	poor	16
22	47 50 08.5	67 50 11.4	21 O/13	2	0	2	3	3.2	4	2	0.5	6.5	21	poor	36
23	47 49 53.7	67 49 13.6	21 O/13	1	6	6	2	6.8	5	2	0.5	7.5	51	fair	3
24	47 49 13.6	67 46 19.7	21 O/13	2	6	4	2	6.4	4	1	0.4	5.4	35	fair	14
25	47 48 57.0	67 45 23.4	21 O/13	2	6	2	3	5.9	4	1	0.4	5.4	32	poor	19
26	47 47 59.8	67 43 39.2	21 O/13	2	6	0	2	4.5	2	1	0.1	3.1	14	poor	37
27	47 49 30.3	67 44 03.1	21 O/13	3	4	4	1	5.5	4	1	0.4	5.4	29	poor	24
28	47 54 58.8	67 44 40.8	21 O/13	1	6	8	2	7.7	2	3	0.1	5.1	39	good	9
29	47 46 52.0	67 43 03.0	21 O/13	2	4	2	3	5.0	4	1	0.3	5.3	27	poor	27
30	47 42 47.9	67 38 14.2	21 O/12	2	6	6	2	7.3	2	3	0.5	5.5	40	good	8
31	47 45 19.3	67 40 24.4	21 O/13	2	6	6	2	7.3	4	1	0.4	5.4	39	good	10
32	47 43 32.4	68 03 14.8	21 N/09	1	2	4	3	4.5	2	2	1.1	5.1	23	poor	33
33	47 45 32.6	68 10 53.0	21 N/16	2	2	2	3	4.1	3	3	1.1	7.1	29	poor	25
34	47 13 15.8	68 57 22.8	21 N/02	2	6	4	2	6.4	2	3	1.0	6.0	38	fair	12
35	47 13 30.6	68 57 28.1	21 N/02	2	4	6	2	6.4	2	3	1.0	6.0	38	fair	11
36	47 12 55.8	68 57 24.9	21 N/02	2	6	6	2	7.3	0	3	1.0	4.0	29	good	26
37	47 22 46.8	68 39 58.0	21 N/07	2	2	4	2	4.5	1	3	1.4	5.4	24	poor	29

[1] (D + J + F + M) x 10/22

[2] P + E + A

[3] Rated by Rock Quality Factor (RQF)
Poor - 0 to 6.0
Fair - 6.0 to 7.0
Good - > 7.0

Table 13 - Site rating summary for selected Crown land sites of slate and slate-like materials in northwestern New Brunswick (refer to Figure 11 and Map Plate 2005-xx for site locations).

CATEGORY	TYPICAL SRN (SITE RATING NUMBER)	TYPICAL RQF (ROCK QUALITY FACTOR)	SITES	TOTAL NUMBER OF SITES	% OF SELECTED SITES
GOOD	>35	7 to 10	2, 17, 18, 28, 30, 31, 36	7	19
FAIR		6 to 7	1, 16, 20, 23, 24, 34, 35	7	19
POOR	<35	3 to 6	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 21, 22, 25, 26, 27, 29, 32, 33, 37	23	62
			TOTALS	37	100

A total of seven (7) or 19 percent of the 37 sites examined are rated as "good" within the context of the rating scheme. The ability of these materials to satisfy accepted product standards for different applications awaits confirmation with sufficient follow-up resource evaluation and appropriate testing.

Of the seven "good" sites, a majority (4) are located on the Gounamitz River map sheet, NTS 21 O/12; two (2) on the States Brook map sheet, NTS 21 O/13; and one (1) on the Connors sheet, NTS 21 O/12 (see Figure 11 and Map Plate 2003-24). These seven sites are briefly discussed in turn below.

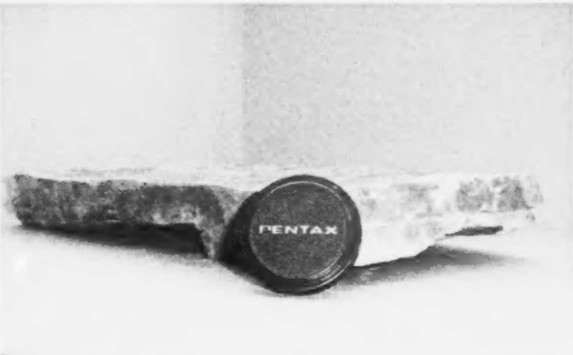


Figure 19 - Photograph of a rock slab from Site 17 (located near the western boundary of the Gounamitz map sheet, 21 O/12).

Site 17, located near the western boundary of the Gounamitz sheet (21 O/12) received the highest ranking (7.5 of 10) of all the 37 sites visited. Although the test results for the sample recovered from this site fall short of roofing slate specifications, the higher than average strength, lower water absorption value and well-developed cleavage (i.e. fissility) of this material suggest that it may have market potential for general landscaping and other related applications. (refer to Figure 19 and the appended field observation data sheets). The exposure, a road cut beside a major logging road, is readily accessible and presents enough relief to allow for the development of a trial working face for further evaluation.

Sites 2, 30, and 31, located in the northeastern part of the Gounamitz map sheet, NTS 21 O/12, occur within an 8 to 10 km wide northeasterly trending band of relatively fissile rock (refer to Figures 20 and 21). This area may warrant further study.

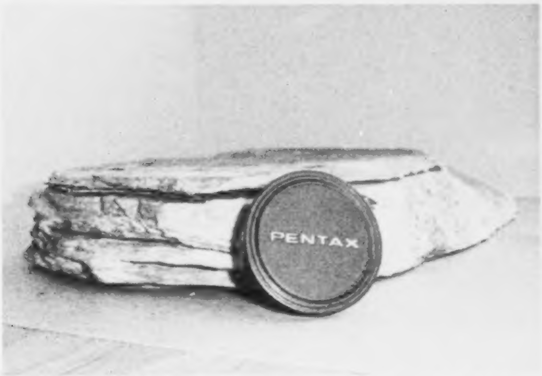


Figure 20 - Photograph of a rock slab from Site 30 (located in the northeastern part of the Gounamitz map sheet, 21 O/12).

Figure 21 - Photograph of Site 30 (located in the northeastern part of the Gounamitz map sheet, 21 O/12).

At **Site 28**, located in the north-central section of States Brook map sheet, NTS 21 O/13, immediately to the east of States Lake, the rock may be of suspect durability, but promising parting characteristics suggest that there may be some development potential (refer to Figures 22 and 23.

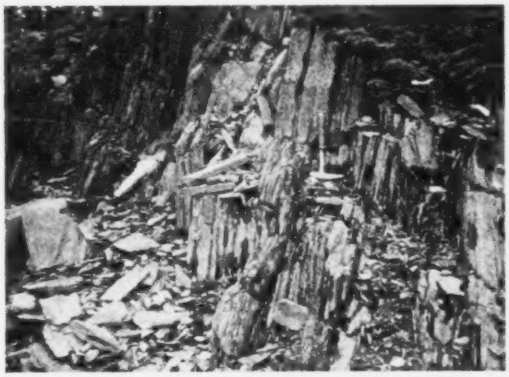


Figure 22 - Photograph of Site 28 (located in the north-central part of the States Brook map sheet, 21 O/13).

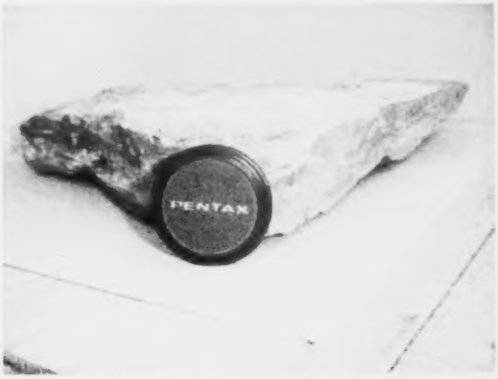


Figure 23 - Photograph of a rock slab from Site 28 (located in the north-central part of the States Brook map sheet, 21 O/13).

Only a limited outcrop was available for examination at **Site 18**, located to the southwest of the States Brook map sheet, NTS 21 O/13. The rock quality is not excellent here, but the degree of fissility may produce marketable stone (Figure 10 and 24).

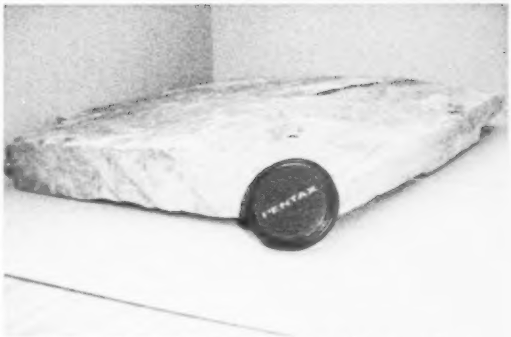


Figure 24 - Photograph of a rock slab from Site 18 (located in the southwest part of the States Brook map sheet, 21 O/13).

The seventh "good" site, **Site 36**, was located at the tip of the pan handle on the Connors map sheet, NTS 21 N/O2. Although on private property, this exposure may reflect the nature of rock on (not readily accessible) Crown land to the northeast.

Summary and Conclusions:

Extensive tracts of early Devonian, low grade metamorphosed, stratified, fine-to medium-grained sedimentary clastic rock including slate, or slate-like materials are distributed throughout northwestern New Brunswick.

Interest in assessing the region's potential for marketable slate and related natural stone resources is driven in part by a growing domestic and regional demand for natural stone products, the presence of a slate operation developed in geologically similar strata near the New Brunswick-Quebec inter-provincial border, and a desire to expand and diversify New Brunswick's mineral industry.

The selected study area is part of the Edmundston Geologic Zone, where deep water marine, medium-to fine-grained sedimentary clastic rocks of the Fortin Group are widespread. Regionally these rocks consist of variously folded (i.e. isoclinal to symmetrical to asymmetrical) calcareous mudstones and argillaceous limestone interbedded with fine-grained lithic wacke and lithic calcareous arenite, locally intruded by granite. In some areas a well developed subvertical slaty cleavage in the more massive, finer grained lithologic units provides interesting possibilities for a potential slate resource.

A preliminary reconnaissance, restricted to primary and major logging roads in the study area resulted in the selection of thirty-seven (37) slate or slate-like rock exposures that were qualitatively rated and further categorized with respect to site development potential. The "quality" component of the rating scheme was weighted to favour sites with fissile rock displaying a well developed cleavage and limited joint sets.

Almost 40% of the sites have been classified as having a "good" to "fair" development potential depending on the type of natural stone product considered. Most of these sites occur in the eastern part of the study area on the Gounamitz River (NTS 21 O/12) and States Brook (NTS 21 O/13) map sheets.

Secondary and tertiary forest access roads were not explored at this preliminary investigation. It is likely that a more detailed survey including this road network will reveal more favourable slate exposures.

Limited analysis and testing of selected engineering properties was undertaken on a few samples. Although some samples displayed relatively low water absorption values, none met the stringent absorption or flexural strength specifications for high end products such as roofing slate.

Most selected sites represent roadside exposures that were often deeply weathered and affected by common road construction practices (i.e. blasting and ripping by heavy machinery). This may explain the rather poor engineering characteristics of some samples. It is expected that better quality materials may be present at depth and beyond the direct influences of previous construction activity.

No slate resource of "roofing" quality was identified, but the fissile nature of the rock at several sites suggests it may be suited for landscaping and a host of aesthetic applications.

Given the cursory nature of this preliminary investigation, the extensive area involved, and limitations associated with sample recovery and testing, it should not be inferred that development prospects for a slate resource are necessarily limited. More detailed exploration and evaluation is required to understand and appreciate the true nature and development potential for this particular resource.

References:

ALCOCK, F. J. 1941. Geology of Matapedia area, Restigouche and Bonventure Counties, New Brunswick and Quebec. Geological Survey of Canada, Map 620A.

ANTONIDES, L. E. 1997. Stone, Dimension, U.S. Geological Survey Minerals Yearbook.

ANTONIDES, L. E., VIRTA, R. L. 1997. Stone, Dimension, U.S. Geological Survey Minerals Yearbook.

ASHURST, J. and Dimes, F. G. 1984. Stone in Building: its use and potential today, Stone Federation, Swindon Press Ltd.

ATLANTIC CONSULTING ECONOMISTS LIMITED, 1988. The Present and Future Markets for Slate Products, Newfoundland.

BATES, R. L. 1969. Geology of the Industrial Rocks and Minerals, Dover Publications, Inc., New York.

BOURQUE, P. A., BRISEBOIS, D. and MALO, M. 1995. Gaspe Belt. In Chapter 4 of Geology of the Appalachian-Caledonian Orogen in Canada and Greenland. Edited by H. Williams. Geological Survey of Canada, Geology of Canada, no. 6, pp. 316-351.

BOWLES, O. 1960. Industrial Minerals and Rocks, The American Institute of Mining, and Petroleum Engineers, New York.

BRITISH GEOLOGICAL SURVEY, 2004. Building and Roofing Stone.

CARROLL, J. I. 2003. Geology of the Kedgwick, Gounamitz River, States Brook and Menneval map areas (NTS 21 O/11, 21 O/12, 21 O/13 and 21 O/14), Restigouche County, New Brunswick. In Current Research 2002. Edited by B.M.W. Carroll. New Brunswick Department of Natural Resources; Minerals, Policy and Planning Division, Mineral Resources Report 2003-4, pp. 23-57.

CULLIN, M., Slate Roofing in Canada.

DIFRANCESCO, C. A., Dolley, T. P. 2004. USGS, Stone (Dimension) Statistics.

DOLLEY, T. P., Stone, Dimension, U.S. Geological Survey Minerals Yearbook, 1999 to 2003.

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR, Mines & Energy Branch, Dimension Stone in Newfoundland and Labrador, Retrieved in January, 2005 from http://www.gov.nl.ca/mines &en/geosurvey/dimension/dimension.stm

GOVERNMENT OF QUEBEC, Natural Resources, Summary and Highlights of the Quebec Mining Industry for 2004, http://www.mrn.gouv.qc.ca/english/publications/online/mines/sh2004/sh2004.asp#Stone

HARBEN, P. W. and Kuzwart, M. 1996. Industrial Minerals: A Global Geology, Metal Bulletin Plc, London.

HARBEN, P. W. and Bates, R. L., The Geology of the non-metallics.

HARBEN, P. W. and Bates, R. L. 1990. Industrial Minerals: Geology and World Deposits, Metal Bulletin Plc, London.

JONES, R.A. 1961. Wild Goose-Baker Lake Area, Restigouche and Madawaska Counties. Geological notes, P.M. 58-1. Mines Branch, Department of Lands and Mines, pp. 1-14.

LEFOND, Industrial Minerals and Rocks.

LEMONS, J. F. Jr. 1996. Stone, Dimension, U.S. Geological Survey Minerals Yearbook.

LESPERANCE, P. J., Greiner, H. R. 1969. Geological Report 128: Squatec-Cabano Area, Quebec Department of Natural Resources.

LOMBARDERO, M., Garcia-Guinea, J., Cardenes, V. 2002. The Geology of Roofing Slate, The Geological Society of London.

MATTHEWS, J. 2004. Trade International Inc., http://jbmatthews.home.mindspring.com/articles.

MILLEN, M., Slate roofing is on the cusp of a revival, Retrieved from http://www.professional roofing.net/article.aspx?A_ID=331

NATIONAL SLATE ASSOCIATION, North American Roofing Slate, Retrieved on April 7, 2005 from http://www.slateassociation.org

NYLANDER, O. O. 1940. Geological Formations of the St. John River Valley, Northern Maine and New Brunswick. Caribou, Maine.

PANAGAPKO, D. 2003. Natural Resources Canada, Mineral and Metal Commodity Review - Stone.

PARKS, W. A. 1914. Report on the Building and Ornamental Stones of Canada, Ottawa Government Printing Bureau.

PERAZZO, P.B., Perazzo, G.P. 2003. Stone Quarries and Beyond, Retrieved from http://www.cagenweb.com/quarries/index.html

POOLE, W.H. 1964. Quebec and New Brunswick, Restigouche Area. In summary of Activities: Field, 1963. Geological Survey of Canada, Paper 64-1, p. 61.

POTTER, R.R., Hamilton, J.B., and Davies, J.L. 1979. Geology Map N.R.-1, New Brunswick Department of Natural Resources, Second Edition.

POWER, W. R. 1994. Industrial Minerals and Rocks (Dimension Stone): Society for Mining, Metallurgy, and Exploration, Inc., Littleton, Colorado.

ROLLINSON, H. 1993. Using Geochemical Data: evaluation, presentation, interpretation, Prentice Hall.

SELWYN, J.E., The history of slate, Retrieved from http://www.professionalroofing.net/article.aspx?A_ID=331

SMITH, M. R. 1999. Stone: Building stone, rock fill and armourstone in construction, The Geological Society, London.

STATE OF MAINE Government Website, Geographical Information Systems Data Catalog - Bedrock, Retrieved December 9, 2004 from http://apollo.ogis.state.me.us/catalog/catalog.asp?state=2&extent=cover

St. PETER, C. 1978. Geology of parts of Restigouche, Victoria and Madawaska Counties, northwestern New Brunswick, NTS 21 N/*, 21 N/9, 21 O/5, 21 O/11, 21 O/14. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Report of Investigation 17, 69 p.

VAGT, O., Natural Resources Canada, Mineral and Metal Commodity Review -Stone,1994 to 2002.

WARD, N. 1995. Slate Waste Tips and Working in Britain, Richards, Moorehead & Laing Ltd.

WHITE, D. M. and Newfoundland Geosciences Ltd., 1988. The Present and Future Markets for Slate Products.

WILLIAMS, M. 1991. The Slate Industry, Shire Publications Ltd.

APPENDIX A - MARKETING DATA

Table A1 - Canadian production of dimension stone, 1998 to 2002

Commodity (tonnes)	1998	1999	2000	2001	2002
Granite	163,000	193,000	238,000	240,000	244,000
Marble	14,000	28,000	31,000	33,000	23,000
Limestone	179,000	185,000	195,000	186,000	307,000
Shale/Slate	18,000	34,000	41,000	43,000	46,000
Sandstone	63,000	65,000	72,000	77,000	81,000

Source: Natural Resources Canada, Mineral Yearbook, 1998 to 2002.

Table A2- Dimension slate sold or used by producers in the United States, by use (1996 to 2003)

QUANTITY (metric tons)								
USE	1996	1997	1998	1999	2000	2001	2002	2003
Flagging	4,340 (17.6 %)	4,850 (19.4 %)	5,510 (18.4 %)	2,110 (7.3 %)	2,400 (8.1 %)	2,450 (10.3 %)	2,800 (15.0 %)	2,280 (12.4 %)
Roofing	10,600 (42.9%)	11,300 (45.1 %)	9,440 (31.5 %)	10,300 (36.0 %)	10,800 (36.6 %)	8,230 (34.5 %)	3,450 (18.5 %)	4,840 (26.2 %)
Structural	1,430 (5.7 %)	1,550 (6.2 %)	1,420 (4.7 %)	2,050 (7.2 %)	2,040 (6.9 %)	2,340 (9.8 %)	2,290 (12.3 %)	2,340 (12.7 %)
Flooring	3,610 (14.6 %)	3,730 (14.9 %)	10,100 (33.7 %)	10,600 (37.0%)	10,700 (36.2 %)	9,450 (39.6 %)	9,040 (48.4 %)	8,790 (47.7 %)
Other	4,740 (19.2 %)	3,610 (14.4 %)	3,530 (11.7 %)	3,560 (12.5 %)	3,600 (12.2 %)	1,390 (5.8 %)	1,080 (5.8 %)	191 (1.0 %)
Total	24,720	25,040	30,000	28,620	29,540	23,860	18,660	18,441

Source: USGS, Minerals Yearbook 1996-2003

APPENDIX B - SITE DESCRIPTIONS WITH GLOSSARY OF TERMS

Site Descriptions - Glossary

Dip - the maximum angle that a structural surface, e.g. bedding or fault plane, makes with the horizontal; measured perpendicular to the strike of the structure and in the vertical plane.

Durability - a subjective measure of the ability of a slate or slate-like rock to remain intact under the combined effects of physical, mechanical and chemical stress.

Fissility - the ease of splitting rock along close parallel planes.

Jointing - a subjective measure of the degree to which secondary joints might adversely affect the breaking characteristics of the rock mass.

Macro scale - any fold or feature that has a thickness greater than 2 centimetres (for this application only).

Micro scale - any fold or feature that has a thickness less than 2 centimetres (for this application only).

Strike - the direction or trend taken by a structural surface, e.g. bedding or fault plane, as it intersects the horizontal.

Roughness - a subjective measure of texture, either smooth or rough.

Undulating - to move with a smooth, wavelike motion.

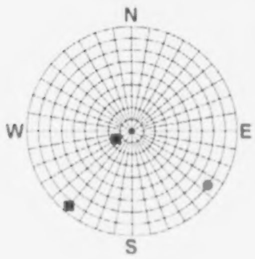
Class 1 - Forest Road - permanent main road system designed to provide access for mineral resource development

Class 2 - Logging Road - all permanent roads that are not designated Forest Roads.

Class 3 - Winter Road - only used after the ground is frozen.

Class 4 - Temporary Road - limited to 400 m in length and used to access resources where no further access is planned.

Polar Projection Diagram:



The orientation of measured joints and cleavage planes are plotted in this polar projection. Those poles occurring around the perimeter of the circle represent sub-vertical planes. Sub-horizontal planes are represented by poles near the centre of the diagram.

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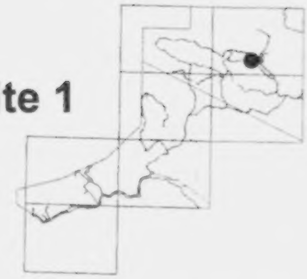
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 1



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 40 52.2 N	67 40 24.7 W
UTM COORDINATES	5296864.2 N	591970.9 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	75 km	91 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	5m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sandstone	siltstone	shale /argillite	slate
			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.		

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	
rough	✓

FISSILITY

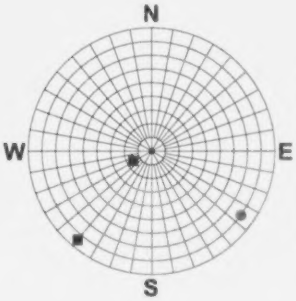
high	medium	low
	✓	

DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	215	80	W	-
▲ bedding	-	-	-	-
■ joint set 1	310	85	NE	10 to 1000
■ joint set 2	335	15	NE	20 to 1000
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF) 3 6 7 10

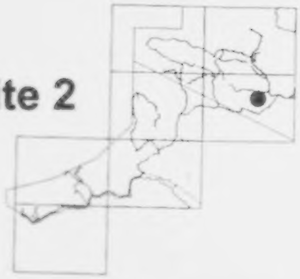
poor	fair	good
	✓	

ROCK QUALITY

NOTES

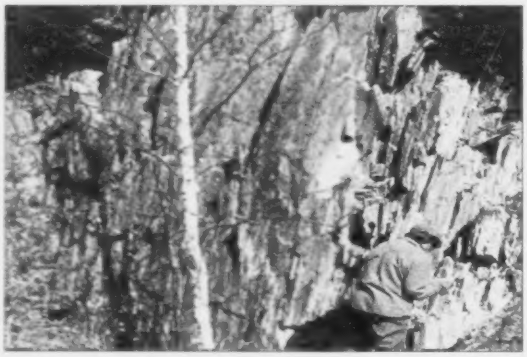
Located 60 m east of site 24. Semi-continuous outcrop exposure along roadway.

Site 2



LOCATION

SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 40 52.4 N	67 40 16.9 W
UTM COORDINATES	5281724 N	599719 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	76 km	89 km
	from primary road	from Edmundston



PHYSICAL DESCRIPTION

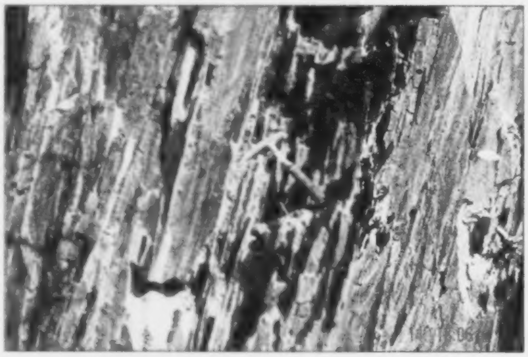
	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE	☐	✓	☐	☐	☐	✓	VEGETATION
HEIGHT, metres	4m to 10m			☐	☐	✓	TERRAIN
				flat	und-ulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA	Dark to bluish grey	COLOUR

	sand-stone	silt-stone	shale /argillite	slate
LITHOLOGY	☐	☐	✓	☐

	fresh	weathered
MUNSELL NO.	☐	☐



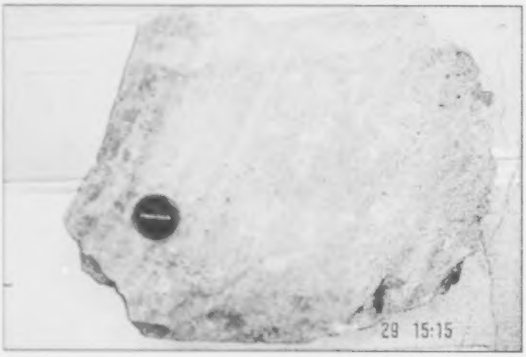
TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓	☐	☐

ROUGHNESS	
smooth	✓
rough	☐

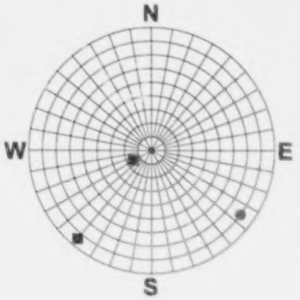
FISSILITY	high	medium	low
	✓	☐	☐

DELETERIOUS MATERIALS	
pyrite	☐
carbonate	✓
quartz	☐
none	☐



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	✓
FAULTS	☐	☐	✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	215	80	W	-
▲ bedding	-	-	-	-
■ joint set 1	310	85	NE	0.1 to 1000
■ joint set 2	335	15	NE	0.2 to 1000
■ joint set 3	-	-	-	-

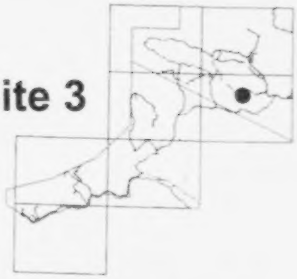
ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
	☐	☐	✓
	poor	fair	good

ROCK QUALITY

NOTES

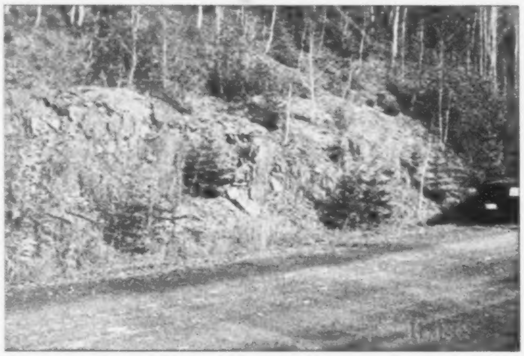
Approximately 275 m east of Site 4. Continuous outcrop for 200 to 300 metres.

Site 3



LOCATION

SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 41 27 N	67 47 26.9 W
UTM COORDINATES	5282645.10 N	590736.67E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	86 km	99 km
	from primary road	from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	2m to 4m		

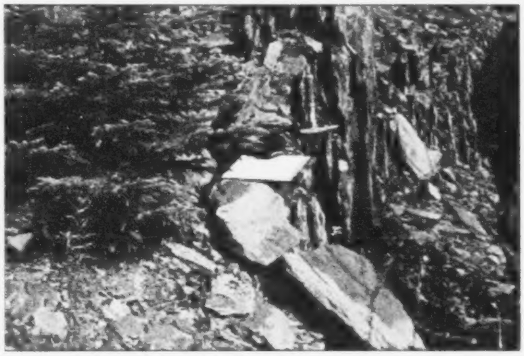
	field	harvested	forested
VEGETATION	☐	☐	☑

	flat	undulating	rugged
TERRAIN	☐	☑	☐

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sandstone ☐	siltstone ☐	shale /argillite ☑	slate ☐

COLOUR	Dark grey to black	
MUNSELL NO.	N4	5Y 6/1
	fresh	weathered



TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
☑	☐	☐

ROUGHNESS

smooth	☐
rough	☑

FISSILITY

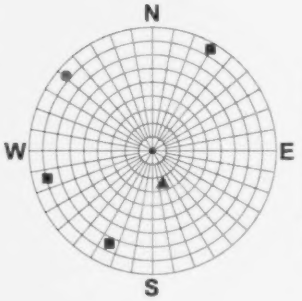
high	medium	low
☐	☑	☐

DELETERIOUS MATERIALS

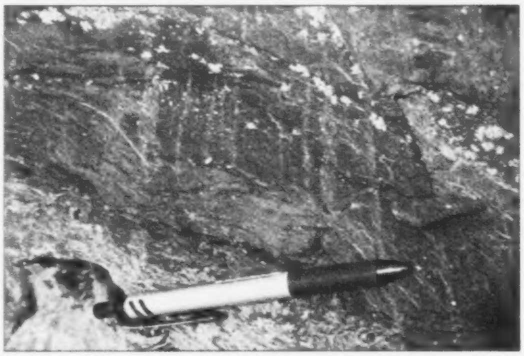
pyrite	☐
carbonate	☑
quartz	☐
none	☐

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☑	☐	☐
FAULTS	☐	☐	☑



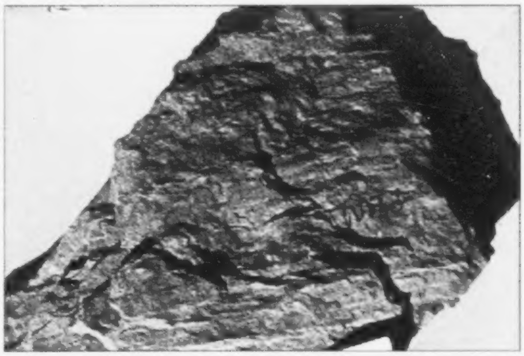
PLANES	strike	dip	dip direction	spacing mm
● cleavage	040	85	SE	10
▲ bedding	256	25	-	-
■ joint set 1	290	75	NE	2000
■ joint set 2	345	80	NE	-
■ joint set 3	120	85	SW	500



ROCK QUALITY FACTOR (RQF) 3 6 7 10

poor	fair	good
☑	☐	☐

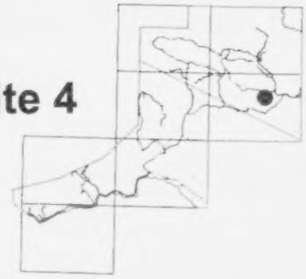
ROCK QUALITY



NOTES

Silty shale. Dark grey to black. Sandy beds (1 to 15 mm) are medium grey. Bedding is near 90° to cleavage. Minor folding noted on bedding planes. Weakly calcareous.

Site 4



LOCATION

SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 40 52.2 N	67 40 24.7 W
UTM COORDINATES	5281713.87 N	599556.81 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	76 km from primary road	89 km from Edmundston

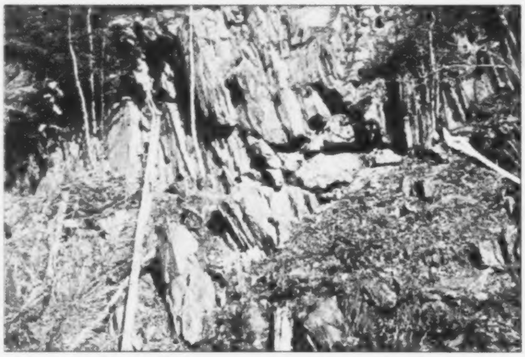
PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	1m to 2m		

	field	harvested	forested
VEGETATION			✓

	flat	und-ulating	rugged
TERRAIN	✓		

ROCK DESCRIPTION



FORMATION/UNIT	TEMISCOUATA			
	sand-stone	silt-stone	shale /argillite	slate
LITHOLOGY			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.	N4	5Y 4/1

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

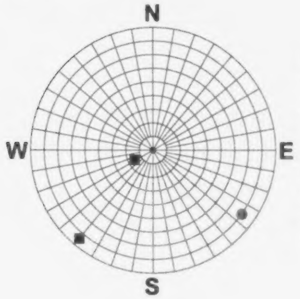
high	medium	low
	✓	

DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	✓
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	✓		
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	215	80	W	-
▲ bedding	-	-	-	-
■ joint set 1	310	85	NE	10 to 1000
■ joint set 2	335	15	NE	20 to 1000
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
	✓		
	poor	fair	good

ROCK QUALITY

NOTES

Poor quality rock. Carbonate and quartz veining at western end of outcrop. Sandy layers and closely spaced joints present. Weathered rind. Moderate to strongly calcareous. Folded sand layers 1mm in thickness.

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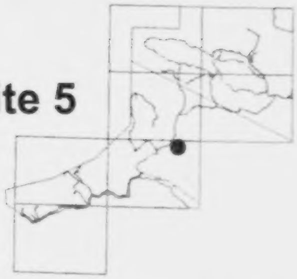
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 5



LOCATION

SHEET / ZONE	NTS 21 N/8	UTM 19
LATITUDE / LONGITUDE	47 29 57 N	68 07 14.7 W
UTM COORDINATES	5261009.7 N	566219.88 E
ROAD CLASSIFICATION	CLASS 2 LOGGING ROAD	
DISTANCE	10 km from primary road	23 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	✓	☐
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION	☐	☐	✓

	flat	undulating	rugged
TERRAIN	☐	☐	✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY	☐	☐	✓	☐

COLOUR	Medium to dark grey

	fresh	weathered
MUNSELL NO.		

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓	☐	☐

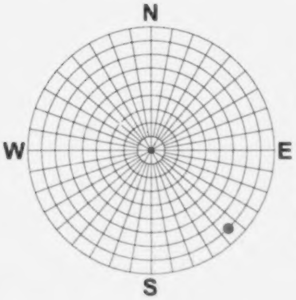
ROUGHNESS	
smooth	✓
rough	☐

FISSILITY	high	medium	low
	✓	☐	☐

DELETERIOUS MATERIALS	
pyrite	☐
carbonate	✓
quartz	☐
none	☐

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	✓
FAULTS	☐	☐	✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	225	80	N	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

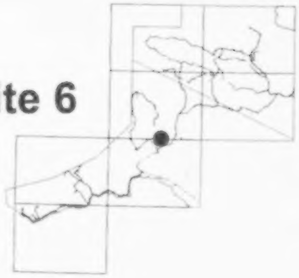
3 – 6 poor	6 – 7 fair	7 – 10 good
✓	☐	☐

ROCK QUALITY

NOTES

Medium grey to black shale, weathering to brownish grey.
Badly broken with irregular fracture pattern.

Site 6



LOCATION

SHEET / ZONE	NTS 21 N/9	UTM 19
LATITUDE / LONGITUDE	47 31 16.7 N	68 13 05.4 W
UTM COORDINATES	5263392.2 N	558858.17 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	8 km from primary road	22 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sandstone	siltstone	shale /argillite	slate
			✓	

COLOUR	Medium to dark grey	
MUNSELL NO.	fresh	weathered

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

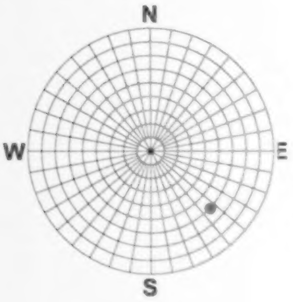
high	medium	low
	✓	

DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			



PLANES	strike	dip	dip direction	spacing mm
● cleavage	225	60	S	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

3 - 6 poor	6 - 7 fair	7 - 10 good
✓		

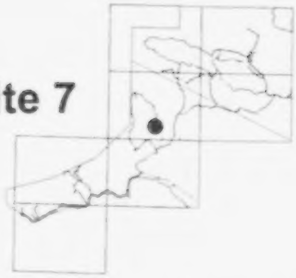
ROCK QUALITY

NOTES

Medium grey to black shale, weathering to brownish grey.
Badly broken with iregular fracture pattern.

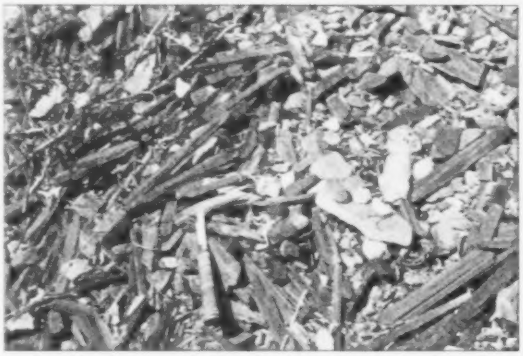
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 7



LOCATION

SHEET / ZONE	NTS 21 N/9	UTM 19
LATITUDE / LONGITUDE	47 34 28.8 N	68 14 55.4 W
UTM COORDINATES	5269300.52 N	556500.8 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	16 km from primary road	30 km from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	1m to 3m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN		✓	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA	
COLOUR	Medium to dark grey	

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY			✓	

	fresh	weathered
MUNSELL NO.		

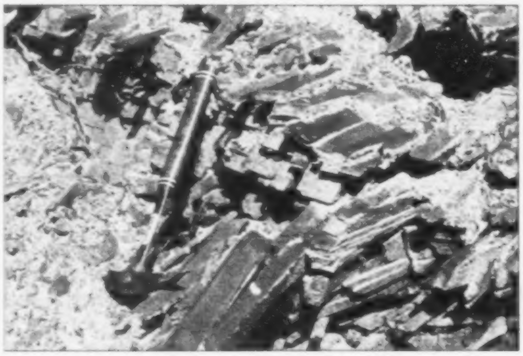
TEXTURE

	fine < 30 um	medium 30 - 50 um	coarse > 50 um
GRAIN SIZE	✓		

ROUGHNESS	
smooth	
rough	✓

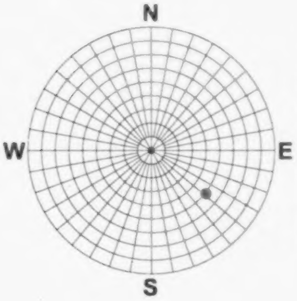
	high	medium	low
FISSILITY			✓

DELETERIOUS MATERIALS	
pyrite	
carbonate	
quartz	
none	✓



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	220	60	N	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

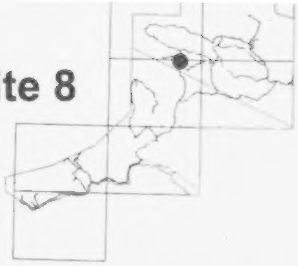
ROCK QUALITY FACTOR (RQF)	3–6	6–7	7–10
	✓		
	poor	fair	good

ROCK QUALITY

NOTES

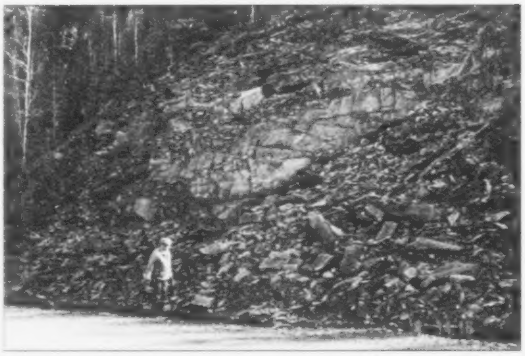
Medium grey shale, weathering to orange-brown.
Badly broken, fracture pattern giving a pencil slate appearance.

Site 8



LOCATION

SHEET / ZONE	NTS 21 N/16	UTM 19
LATITUDE / LONGITUDE	47 29 57 N	68 07 14.7 W
UTM COORDINATES	5290464.65 N	566115.91 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	34 km	47 km
	from primary road	from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

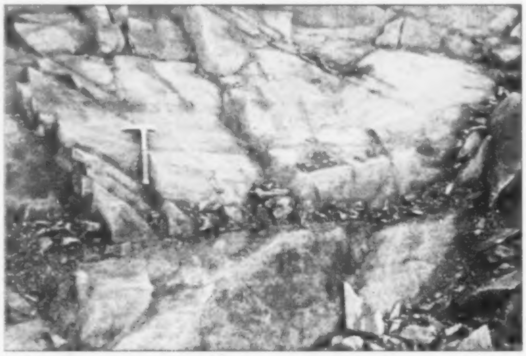
	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
	sandstone	siltstone	shale /argillite	slate
LITHOLOGY			✓	

COLOUR	Medium to dark grey	
	fresh	weathered
MUNSELL NO.		



TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	
rough	✓

FISSILITY

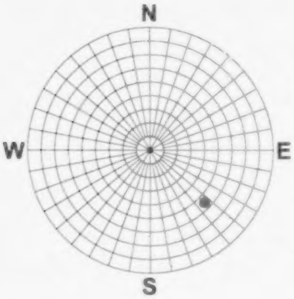
high	medium	low
		✓

DELETERIOUS MATERIALS

pyrite	✓
carbonate	✓
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	225	55	N	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

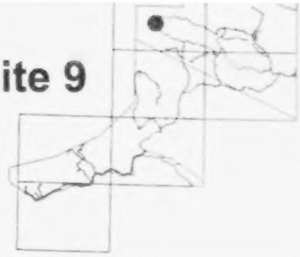
3 – 6 poor	6 – 7 fair	7 – 10 good
✓		

ROCK QUALITY

NOTES

Medium grey shale, weathering to brownish grey. Iron staining on fractures. Badly broken with irregular fracture pattern.

Site 9



LOCATION

SHEET / ZONE	NTS 21 N/16	UTM 19
LATITUDE / LONGITUDE	47 52 33.8 N	68 17 24.3 W
UTM COORDINATES	5302770 N	553134 E
ROAD CLASSIFICATION	CLASS 2 LOGGING ROAD	
DISTANCE	63 km	76 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE		✓				✓	VEGETATION
HEIGHT, metres	< 2 m				✓		TERRAIN
				flat	und-ulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				Dark grey to black	COLOUR
LITHOLOGY	✓				N3 | 5Y 4/1	MUNSELL NO.
	sand-stone	silt-stone	shale /argillite	slate	fresh | weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓	

ROUGHNESS

smooth	
rough	✓

FISSILITY

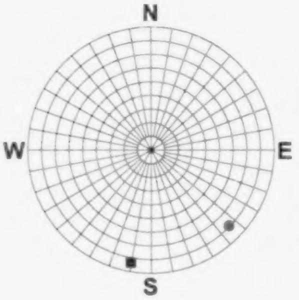
high	medium	low
		✓

DELETERIOUS MATERIALS

	pyrite
✓	carbonate
	quartz
	none

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	225	80	W	-
▲ bedding	-	-	-	-
■ joint set 1	300	85	N	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF) 3–6	6–7	7–10
✓		
poor	fair	good

ROCK QUALITY

NOTES

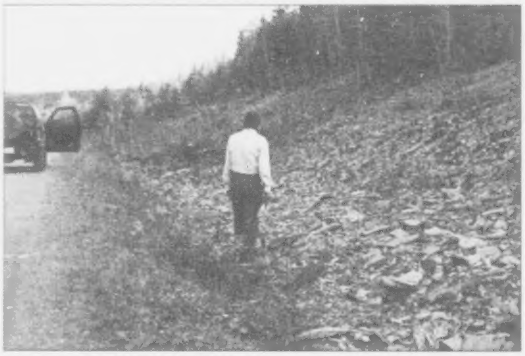
Dark grey to black sandstone, weathering to light grey. Poor quality material. Site is representative of area. Highly calcareous. Irregular sand lenses.

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 10

LOCATION

SHEET / ZONE	NTS 21 N/16	UTM 19
LATITUDE / LONGITUDE	47 52 08.2 N	68 08 27.5 W
UTM COORDINATES	5302089.5 N	564241.8 E
ROAD CLASSIFICATION	CLASS 2 FOREST ROAD	
DISTANCE	73 km	87 km
	from primary road	from Edmundston

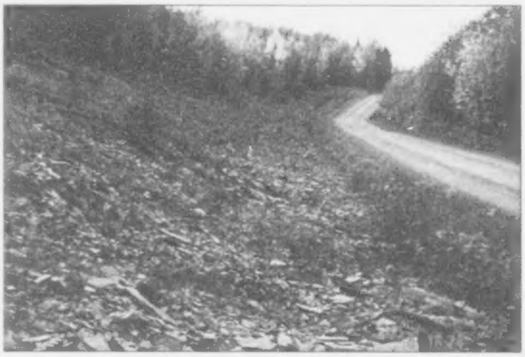


PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE		✓			✓		VEGETATION
HEIGHT, metres	2m to 3m			✓			TERRAIN
				flat	undulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				Medium to dark grey		COLOUR
LITHOLOGY		✓			N4	5Y 2/1	MUNSELL NO.
	sandstone	siltstone	shale /argillite	slate	fresh	weathered	



TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

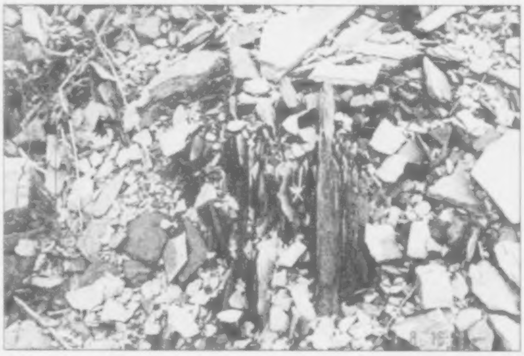
smooth	✓
rough	

FISSILITY

high	medium	low
✓		

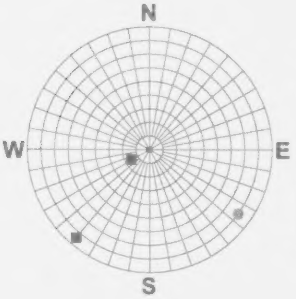
DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	215	80	W	-
▲ bedding	-	-	-	-
■ joint set 1	310	85	NE	0.1 to 1m
■ joint set 2	335	15	NE	0.2 to 1m
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
	✓		
	poor	fair	good

ROCK QUALITY

NOTES

Semi-continuous outcrop exposure along roadway.

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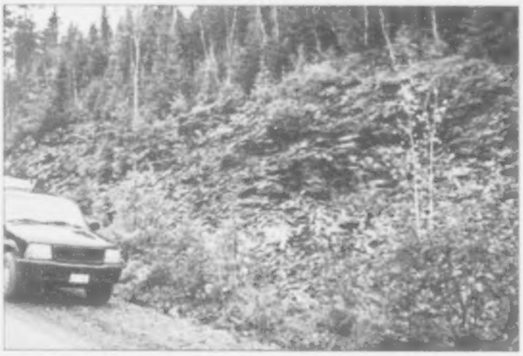
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 11

LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 48 42.8 N	67 56 18.0 W
UTM COORDINATES	5295939 N	579482 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	69 km from primary road	85 km from Edmundston



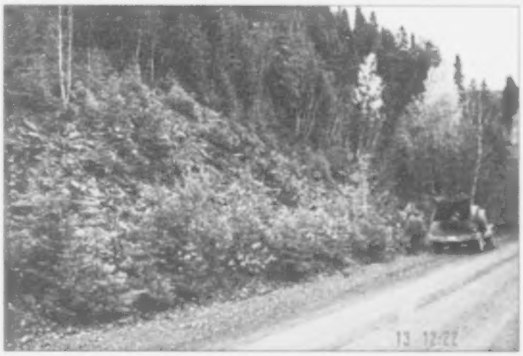
PHYSICAL DESCRIPTION

EXPOSURE TYPE: natural outcrop ☐ road cut ☑ quarry ☐

HEIGHT, metres: 4m to 10m

VEGETATION: field ☐ harvested ☐ forested ☑

TERRAIN: flat ☐ undulating ☐ rugged ☑



ROCK DESCRIPTION

FORMATION/UNIT: TEMISCOUATA

LITHOLOGY: sandstone ☐ siltstone ☐ shale /argillite ☑ slate ☐

COLOUR: Medium to dark grey

MUNSELL NO.: N5 (fresh) 10YR 4/2 (weathered)

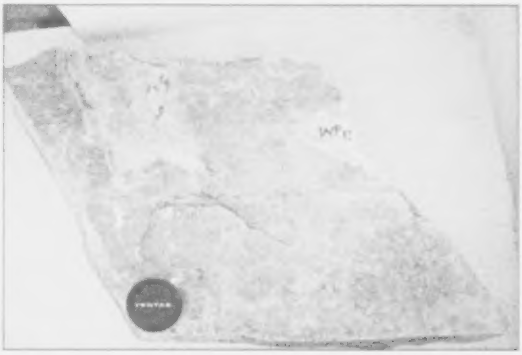
TEXTURE

GRAIN SIZE: fine < 30 um ☑ medium 30 - 50 um ☐ coarse > 50 um ☐

ROUGHNESS: smooth ☑ rough ☐

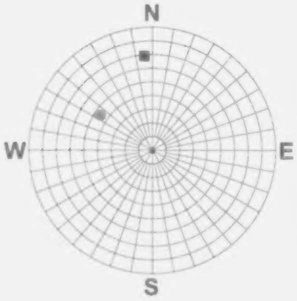
FISSILITY: high ☐ medium ☑ low ☐

DELETERIOUS MATERIALS: pyrite ☐ carbonate ☐ quartz ☐ none ☑



STRUCTURAL FEATURES

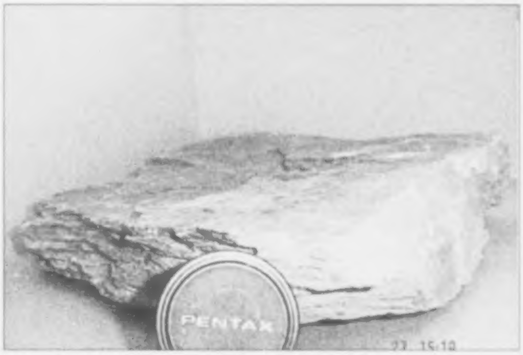
	micro scale	macro scale	none observed
FOLDS	✓		
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	032	45	S	-
▲ bedding	-	-	-	-
■ joint set 1	085	70	S	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF): 3 – 6 poor ☑ 6 – 7 fair ☐ 7 – 10 good ☐

ROCK QUALITY



NOTES

Kink banding noted. Preferentially weathered along cleavage surface. Micaeous.

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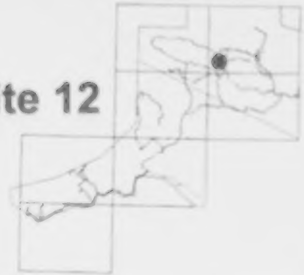
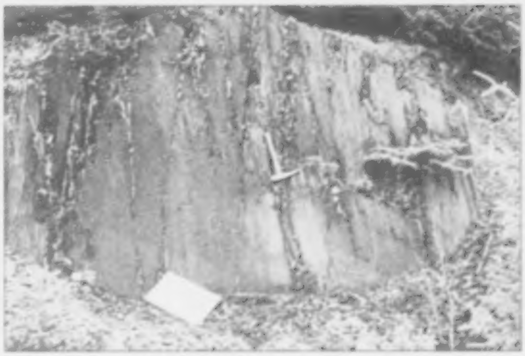
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 12



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 10.0 N	67 56 13.3 W
UTM COORDINATES	5296771 N	579568 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	68 km	84 km
	from primary road	from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE		✓				✓	VEGETATION
HEIGHT, metres	4m to 10m					✓	TERRAIN
				flat	undulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				
LITHOLOGY	✓				
	sand-stone	silt-stone	shale /argillite	slate	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.		

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

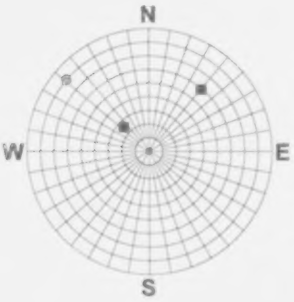
high	medium	low
	✓	

DELETERIOUS MATERIALS

pyrite	
carbonate	
quartz	
none	✓

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	040	80	S	-
▲ bedding	-	-	-	-
■ joint set 1	130	60	W	-
■ joint set 2	042	25	S	0.1 to 1m
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
	✓		
	poor	fair	good

ROCK QUALITY

NOTES

100 metres east of Site 11. Sandstone. Brown weathering. Low relief.

Site 13

LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 57.9 N	67 50 39.7 W
UTM COORDINATES	5298356.85 N	586483.02 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	69 km from primary road	84 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION	☐	☐	☑

	flat	undulating	rugged
TERRAIN	☐	☐	☑

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA
COLOUR	Medium to dark grey

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY	☐	☐	☑	☐

	fresh	weathered
MUNSELL NO.		

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	☑	☐	☐

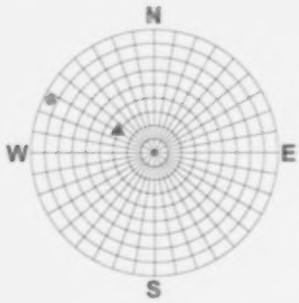
ROUGHNESS	
smooth	☑
rough	☐

FISSILITY	high	medium	low
	☐	☐	☑

DELETERIOUS MATERIALS	
pyrite	☐
carbonate	☑
quartz	☐
none	☐

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	☑
FAULTS	☐	☐	☑



PLANES	strike	dip	dip direction	spacing mm
● cleavage	028	86	S	-
▲ bedding	028	32	S	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF) 3 6 7 10

poor	fair	good
☑	☐	☐

ROCK QUALITY

NOTES

Medium grey shale, weathering to brownish grey.
Badly broken with irregular fracture pattern.

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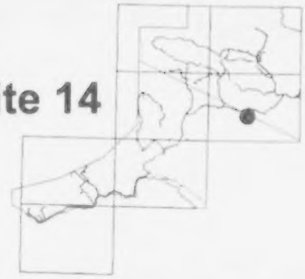
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 14



LOCATION

SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 36 54.9 N	67 47 17.1 W
UTM COORDINATES	5298356.85 N	586483.02 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	47 km	60 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	2m to 4m		

	field	harvested	forested
VEGETATION	☐	☐	☑

	flat	undulating	rugged
TERRAIN	☐	☑	☐

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA	
COLOUR	Medium to dark grey	

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY	☐	☐	☑	☐

	fresh	weathered
MUNSELL NO.		

TEXTURE

	fine < 30 um	medium 30 - 50 um	coarse > 50 um
GRAIN SIZE	☑	☐	☐

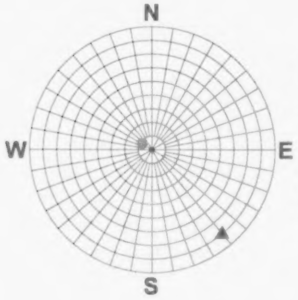
ROUGHNESS	
smooth	☑
rough	☐

	high	medium	low
FISSILITY	☐	☑	☐

DELETERIOUS MATERIALS	
pyrite	☐
carbonate	☑
quartz	☐
none	☐

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	☑
FAULTS	☐	☐	☑



PLANES	strike	dip	dip direction	spacing mm
● cleavage	030	10	N	-
▲ bedding	229	80	S	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
ROCK QUALITY	☑ poor	☐ fair	☐ good

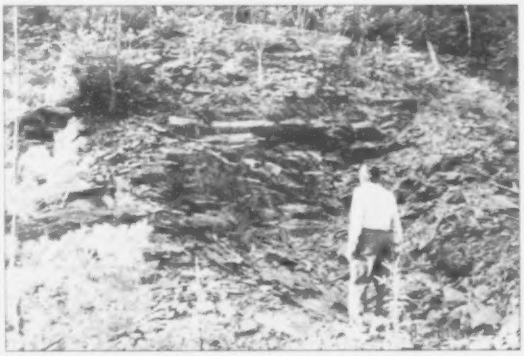
NOTES

Medium grey shale, fissile and badly broken.

Site 15

LOCATION

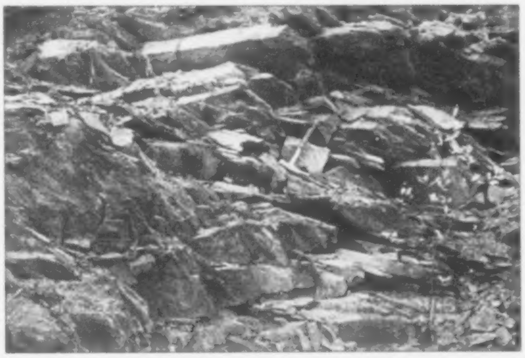
SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 36 40.1 N	67 47 08.9 W
UTM COORDINATES	5273793.21 N	591251.02 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	68 km from primary road	84 km from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	✓	☐
HEIGHT, metres	2m to 4m		

field	harvested	forested	
☐	☐	✓	VEGETATION
☐	☐	✓	TERRAIN
flat	undulating	rugged	



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	☐	☐	✓	☐
	sandstone	siltstone	shale /argillite	slate

Medium to dark grey		COLOUR
☐	☐	MUNSELL NO.
fresh	weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓	☐	☐

ROUGHNESS

smooth	☐
rough	✓

FISSILITY

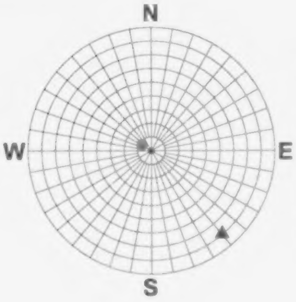
high	medium	low
✓	☐	☐

DELETERIOUS MATERIALS

☐	pyrite
✓	carbonate
☐	quartz
☐	none

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	✓
FAULTS	☐	☐	✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	030	10	N	-
▲ bedding	229	80	S	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 - 6	6 - 7	7 - 10
	✓	☐	☐
	poor	fair	good

ROCK QUALITY

NOTES

Medium grey shale, irregular fracturing. Temporary borrow site for road construction.

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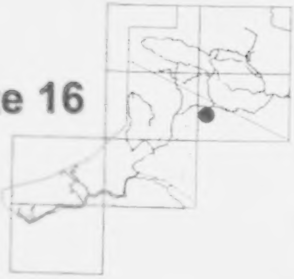
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 16



LOCATION

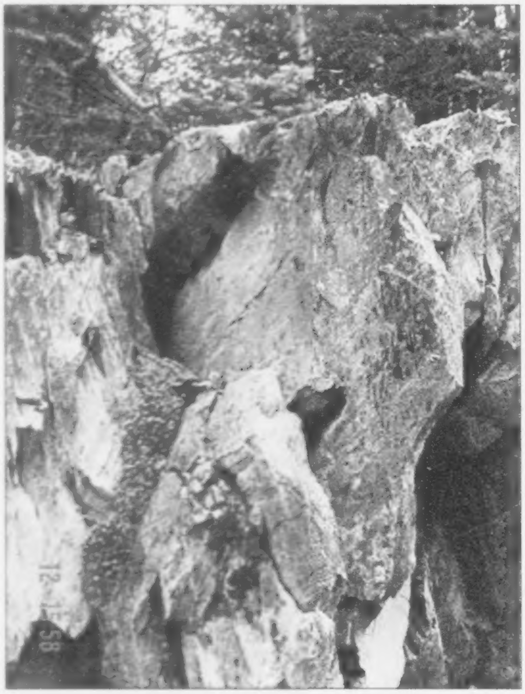
SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 37 23.3 N	67 57 05.6 W
UTM COORDINATES	5274944.96 N	57877.03 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	34 km from primary road	47 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	2m to 4m		

	field	harvested	forested
VEGETATION	☐	☐	☑

	flat	und-ulating	rugged
TERRAIN	☐	☐	☑



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA	
COLOUR	Medium grey	
MUNSELL NO.	fresh:	weathered:

	sand-stone	silt-stone	shale /argilite	slate
LITHOLOGY	☐	☐	☑	☐

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	☐	☑	☐

ROUGHNESS

smooth ☐
rough ☑

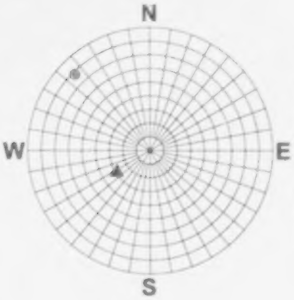
FISSILITY	high	medium	low
	☐	☐	☑

DELETERIOUS MATERIALS

pyrite ☐
carbonate ☐
quartz ☐
none ☑

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	☑
FAULTS	☐	☐	☑



PLANES	strike	dip	dip direction	spacing mm
● cleavage	044	80	S	-
▲ bedding	320	30	N	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6 poor	6 – 7 fair	7 – 10 good
	☐	☑	☐

ROCK QUALITY

NOTES

Fine sand beds present (1mm to 15 mm). Irregular cleavage surface. Limited exposure.

Site 17

LOCATION

SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 37 30.9 N	67 58 14.1 W
UTM COORDINATES	5275163 N	577343 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	33 km from primary road	46 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10 m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

	sandstone	siltstone	shale /argillite	slate
FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY			✓	

	fresh	weathered
COLOUR	Medium grey to black	
MUNSELL NO.	N 3	5G 2/1

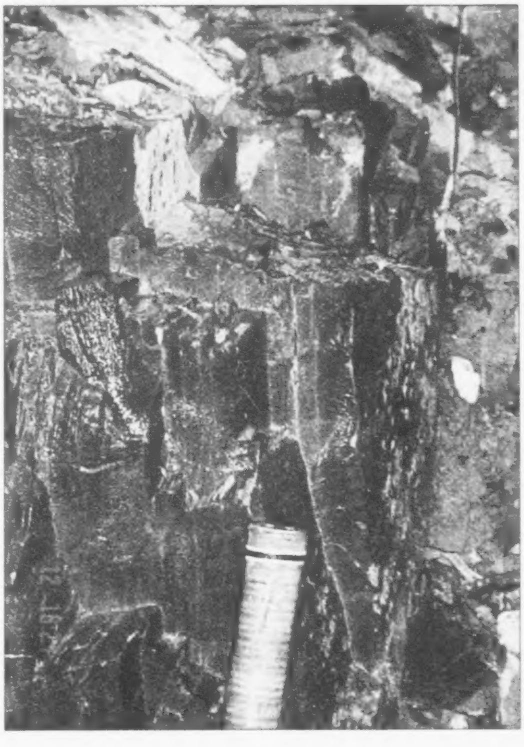
TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓		

ROUGHNESS	
smooth	✓
rough	

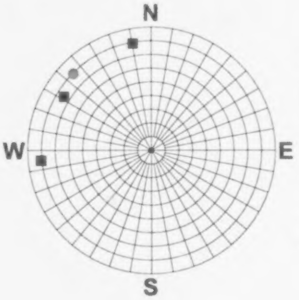
FISSILITY	high	medium	low
	✓		

DELETERIOUS MATERIALS	
pyrite	
carbonate	✓
quartz	
none	



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	044	80	S	-
▲ bedding	-	-	-	-
■ joint set 1	078	80	S	-
■ joint set 2	032	75	S	-
■ joint set 3	355	80	E	-

ROCK QUALITY FACTOR (RQF)	3–6 poor	6–7 fair	7–10 good
ROCK QUALITY			✓

NOTES

Medium grey to black shale to slate, weathering to brownish green. Major joint set along cleavage plane. Bedding near right angles to cleavage. Weakly calcareous.
Outcrop exposure 20m to 30m in length along roadway.

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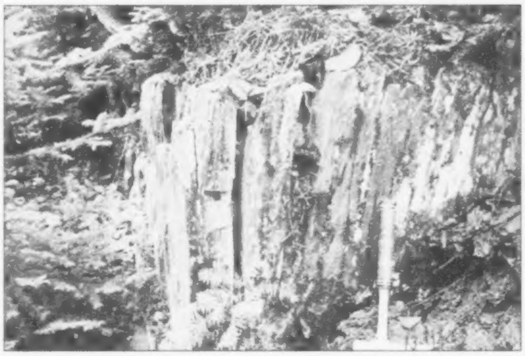
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 18

LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 48 35.0 N	67 54 26.2 W
UTM COORDINATES	5295729 N	581812 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	61 km from primary road	76 km from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY			✓	

COLOUR	Medium to dark grey	
MUNSELL NO.	N5 fresh	10 YR 4/2 weathered

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

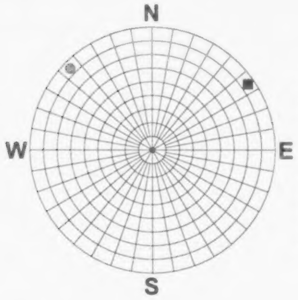
high	medium	low
✓		

DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	045	85	S	2 to 5
▲ bedding	-	-	-	-
■ joint set 1	145	85	W	2000
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
			✓
	poor	fair	good

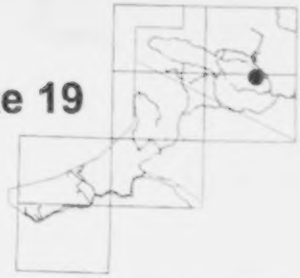
ROCK QUALITY

NOTES

20 m to 30 m of outcrop exposure along roadway. Preferential weathering along cleavage. Weakly to moderately calcareous.

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 19



LOCATION

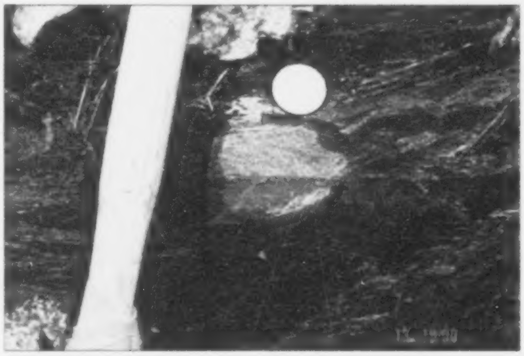
SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 45 26.3 N	67 42 47.3 W
UTM COORDINATES	5290126 N	596442 E
ROAD CLASSIFICATION	CLASS 2 FOREST ROAD	
DISTANCE	84 km	98 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	2m to 4m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN		✓	



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY			✓	

COLOUR	Dark grey to black	
MUNSELL NO.	N4	10 YR 5/4
	fresh	weathered

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	
rough	✓

FISSILITY

high	medium	low
	✓	

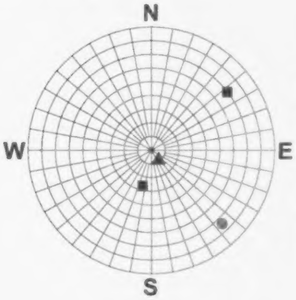
DELETERIOUS MATERIALS

	pyrite
✓	carbonate
	quartz
	none

PENTAX
27 15:47

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	228	75	N	2 to 5
▲ bedding	220	05	N	-
■ joint set 1	142	70	S	-
■ joint set 2	285	28	N	500
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

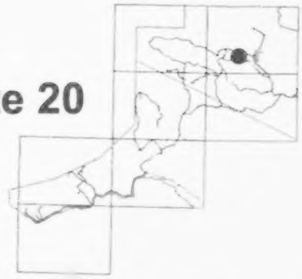
3 – 6 poor	6 – 7 fair	7 – 10 good
✓		

ROCK QUALITY

NOTES

Indurated siltstone to shale. Very difficult to break. Highly calcareous. Hairline veining with iron carbonate infilling (less than 1 mm). Preferential weathering along cleavage planes. Thinly laminated with sand layers. Bedding at high angle to cleavage.

Site 20



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 55.4 N	67 51 05.3 W
UTM COORDINATES	5298273 N	585952 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	69 km	84 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE		✓				✓	VEGETATION
HEIGHT, metres	4m to 10m					✓	TERRAIN
				flat	undulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				Light to dark brown	COLOUR
LITHOLOGY		✓				MUNSELL NO.
	sandstone	siltstone	shale /argillite	slate	fresh / weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

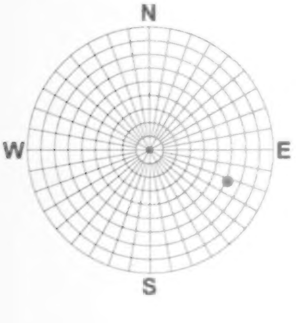
high	medium	low
✓		

DELETERIOUS MATERIALS

✓	pyrite
	carbonate
	quartz
	none

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	205	65	W	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

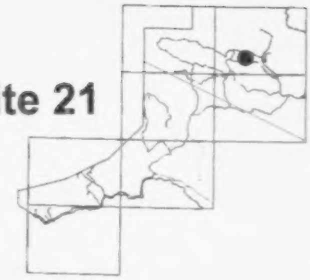
3 - 6	6 - 7	7 - 10
	✓	
poor	fair	good

ROCK QUALITY

NOTES

Large road cut exposure (800 m to 1000m).
Irregular fractures producing small rock fragments.
Iron staining on some joints.

Site 21



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 55.1 N	67 50 42.8 W
UTM COORDINATES	5298281 N	586421 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	70 km	85 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

field	harvested	forested	
		✓	VEGETATION
		✓	TERRAIN
flat	undulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY			✓	
	sandstone	siltstone	shale /argillite	slate

Medium to dark grey		COLOUR
N4	5Y 4/1	MUNSELL NO.
fresh	weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

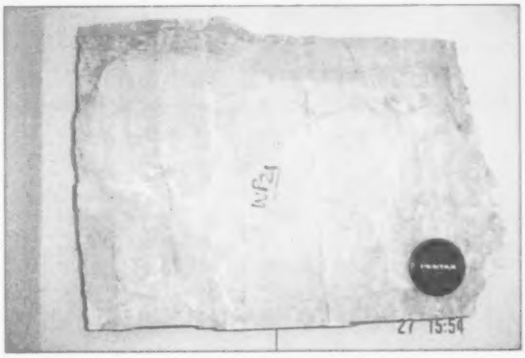
smooth	
rough	✓

FISSILITY

high	medium	low
	✓	

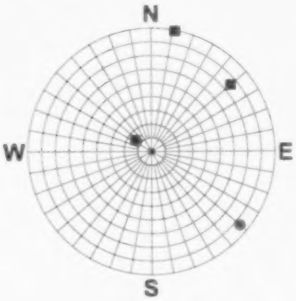
DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓

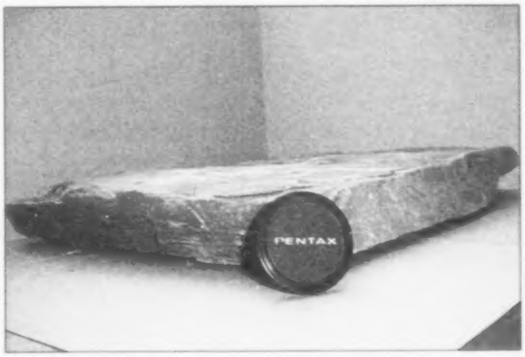


PLANES	strike	dip	dip direction	spacing mm
● cleavage	220	85	N	2 to 3
▲ bedding	-	-	-	-
■ joint set 1	100	90	-	500 to 1000
■ joint set 2	030	15	S	-
■ joint set 3	140	75	SW	500 to 1500

ROCK QUALITY FACTOR (RQF) 3 6 7 10

poor	fair	good
	✓	

ROCK QUALITY



NOTES

Semi-continuous large outcrop (500 m).Medium grey to dark grey shale, weathering to brownish grey. Bedding perpendicular to cleavage. Thin beds (1 mm to 5 mm) of sand, carbonate bearing. Rusty brown coating on joint surfaces.

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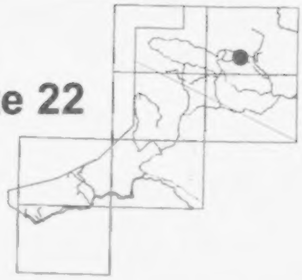
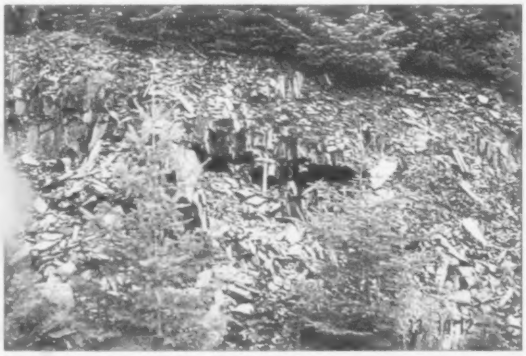
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 22



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 50 01.5 N	67 50 11.4 W
UTM COORDINATES	5298476 N	587069 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	71 km	86 km
	from primary road	from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA
COLOUR	Medium to dark grey

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY			✓	

	fresh	weathered
MUNSELL NO.		

TEXTURE

	fine < 30 um	medium 30 - 50 um	coarse > 50 um
GRAIN SIZE	✓		

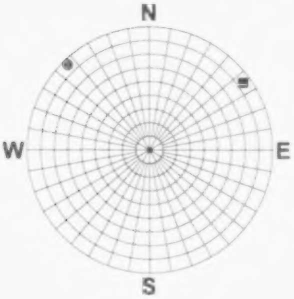
ROUGHNESS	
smooth	✓
rough	

	high	medium	low
FISSILITY			✓

DELETERIOUS MATERIALS	
pyrite	
carbonate	
quartz	
none	✓

STRUCTURAL FEATURES

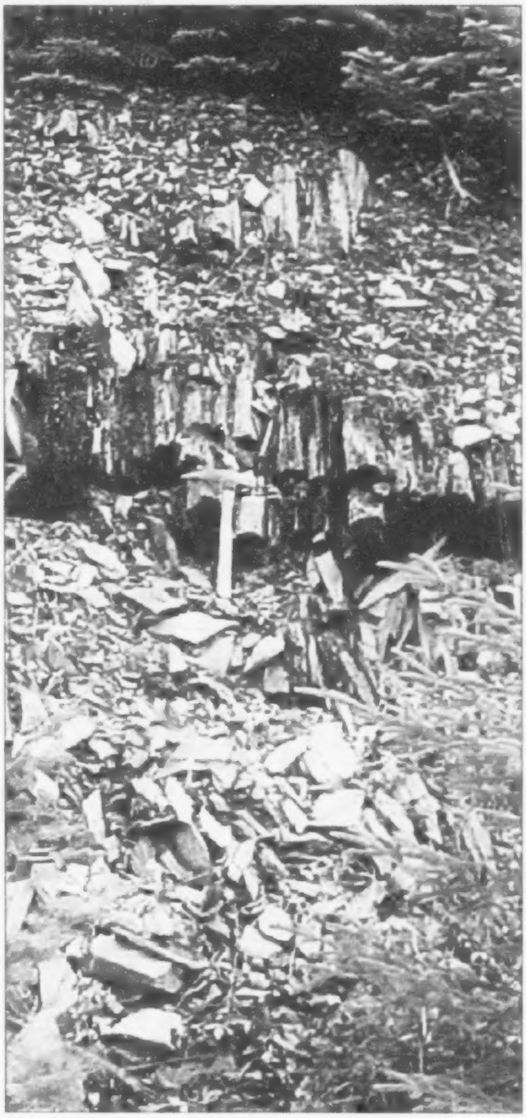
	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	045	85	S	-
▲ bedding	-	-	-	-
■ joint set 1	145	85	W	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	poor (3–6)	fair (6–7)	good (7–10)
	✓		

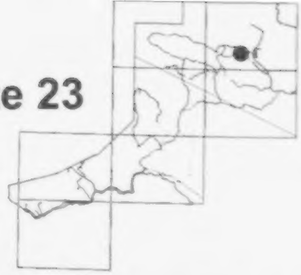
ROCK QUALITY



NOTES

800 metres east of Site 21. Highly fractured.

Site 23



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 46.6 N	67 49 13.6 W
UTM COORDINATES	5298036 N	588277 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	72 km from primary road	87 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	>10m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sandstone	siltstone	shale /argillite	slate
			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.	N3	5Y 5/2

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓		

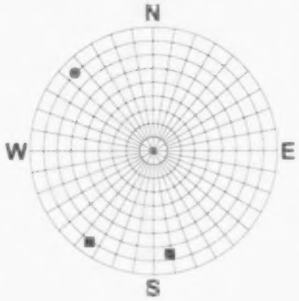
ROUGHNESS	
smooth	
rough	✓

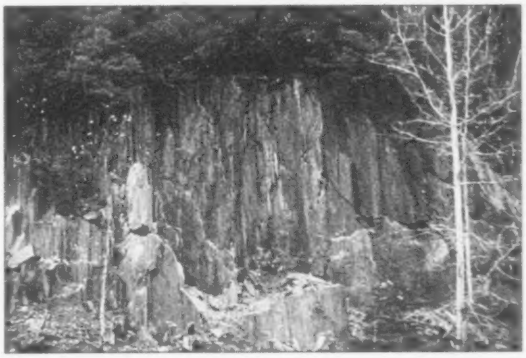
FISSILITY	high	medium	low
	✓		

DELETERIOUS MATERIALS	
pyrite	
carbonate	✓
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓





PLANES	strike	dip	dip direction	spacing mm
● cleavage	045	85	S	-
▲ bedding	-	-	-	-
■ joint set 1	305	80	N	200 to 1000
■ joint set 2	262	70	N	200 to 300
■ joint set 3	-	-	-	-

ROCK QUALITY

ROCK QUALITY FACTOR (RQF)	3 – 6 poor	6 – 7 fair	7 – 10 good
		✓	

NOTES

Dark grey to black weathering to greenish grey shale. Rusty brown weathering on joint surfaces. Irregular cleavage surface.

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PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 24

LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 06.6 N	67 46 19.8 W
UTM COORDINATES	5296855 N	591911 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	75 km from primary road	91 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	5m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	und-ulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			

	sand-stone	silt-stone	shale /argillite	slate
LITHOLOGY			✓	

COLOUR	Medium to dark grey	
MUNSELL NO.	N3 fresh	5Y 4/1 weathered

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	
rough	✓

FISSILITY

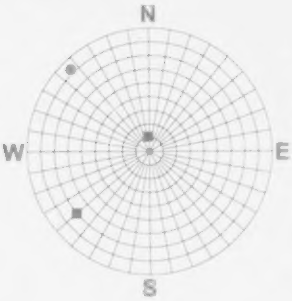
high	medium	low
	✓	

DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES

	strike	dip	dip direction	spacing mm
● cleavage	045	85	S	2 to 5
▲ bedding	-	-	-	-
■ joint set 1	320	70	NE	500 to 2000
■ joint set 2	080	10	S	>1000
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
		✓	
	poor	fair	good

ROCK QUALITY

NOTES

Medium grey to dark grey shale, weathering to greenish grey. Large (100 m+) continuous outcrop. Weakly carbonate. Irregular preferential weathering along cleavage planes.

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 25

LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 48 50.0 N	67 45 23.5 W
UTM COORDINATES	5296362 N	5293089 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	78 km from primary road	94 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	und-ulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sand-stone	silt-stone	shale /argillite	slate
			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.		

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓		

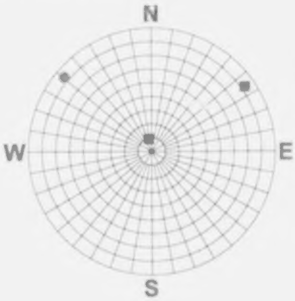
ROUGHNESS	
smooth	✓
rough	

FISSILITY	high	medium	low
			✓

DELETERIOUS MATERIALS	
pyrite	
carbonate	
quartz	
none	✓

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



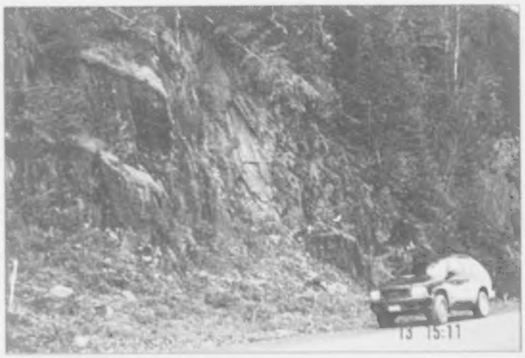
PLANES	strike	dip	dip direction	spacing mm
● cleavage	045	85	S	2 to 5
▲ bedding	-	-	-	-
■ joint set 1	145	85	W	500 to 2000
■ joint set 2	080	10	S	-
■ joint set 3	-	-	-	-

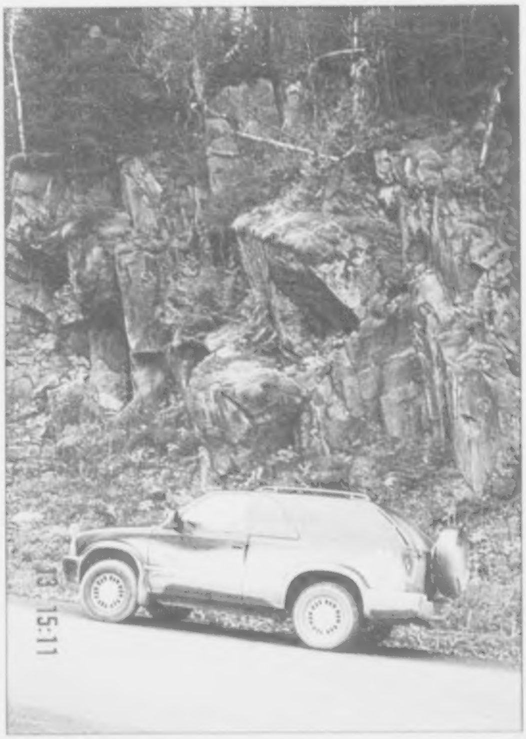
ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
	✓		
	poor	fair	good

ROCK QUALITY

NOTES

One kilometre east of Site 24. Medium grey to dark grey shale, weathering to greenish grey. Rock is similar to that at Site 24.





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PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 26

LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 47 52.8 N	67 43 39.3 W
UTM COORDINATES	5294631 N	595286 E
ROAD CLASSIFICATION	CLASS 3 WINTER ROAD	
DISTANCE	92 km from primary road	106 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	< 2m		

	field	harvested	forested
VEGETATION	☐	☑	☐

	flat	und-ulating	rugged
TERRAIN	☑	☐	☐

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA
COLOUR	Medium to dark grey
MUNSELL NO. (fresh / weathered)	

	sand-stone	silt-stone	shale /argillite	slate
LITHOLOGY	☐	☐	☑	☐

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	☑	☐	☐

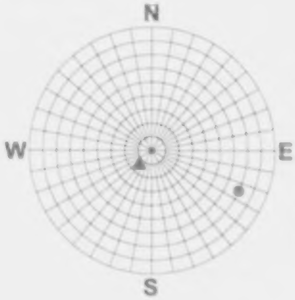
ROUGHNESS	
smooth	☑
rough	☐

FISSILITY	high	medium	low
	☐	☐	☑

DELETERIOUS MATERIALS	
pyrite	☐
carbonate	☑
quartz	☐
none	☐

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	☑
FAULTS	☐	☐	☑



PLANES	strike	dip	dip direction	spacing mm
● cleavage	215	70	NW	-
▲ bedding	315	05	N	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

3 – 6	6 – 7	7 – 10
☑	☐	☐
poor	fair	good

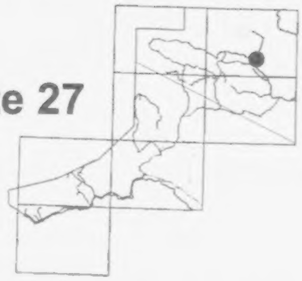
ROCK QUALITY

NOTES

Outcrop showing bedding/cleavage relationship.
Low relief and poor quality.

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 27



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 49 23.3 N	67 44 03.2 W
UTM COORDINATES	5297416 N	594744 E
ROAD CLASSIFICATION	CLASS 2 LOGGING ROAD	
DISTANCE	80 km	95 km
	from primary road	from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

field	harvested	forested	
		✓	VEGETATION
		✓	TERRAIN
flat	undulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY			✓	
	sand-stone	silt-stone	shale /argilite	slate

Medium to dark grey		COLOUR
N3	10 YR 4/2	MUNSELL NO.
fresh	weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 m
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

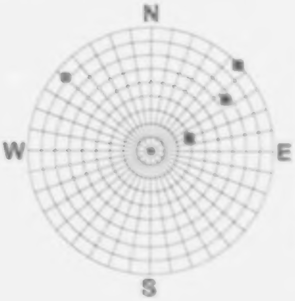
high	medium	low
✓		

DELETERIOUS MATERIALS

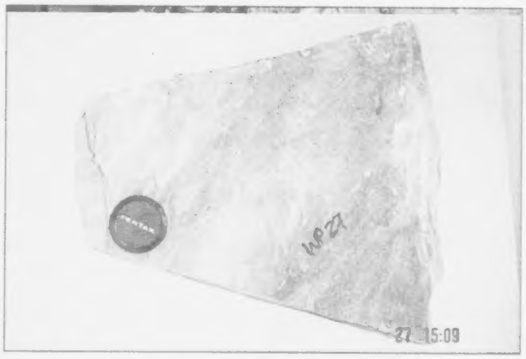
✓	pyrite
✓	carbonate
	quartz
	none

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



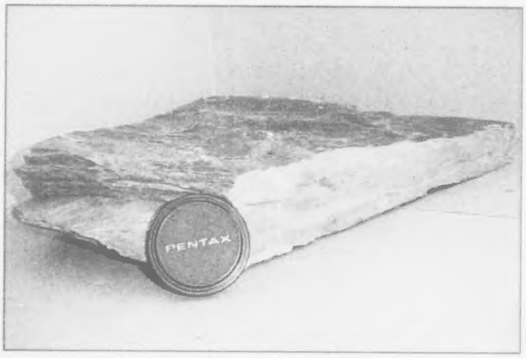
PLANES	strike	dip	dip direction	spacing mm
● cleavage	040	80	S	1 to 3
▲ bedding	-	-	-	-
■ joint set 1	145	65	W	100 to 1000
■ joint set 2	160	30	W	-
■ joint set 3	135	90	-	50



ROCK QUALITY FACTOR (RQF)

3 – 6	6 – 7	7 – 10
✓		
poor	fair	good

ROCK QUALITY



NOTES

Thinly laminated 1 to 3 mm. fine cross laminations.
Sandy layers (2 to 12 mm) contain pyrite and carbonate
Fractured surfaces weather to brown.

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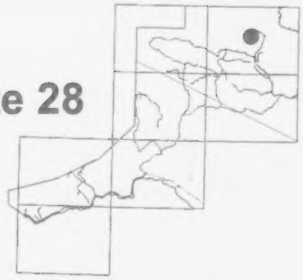
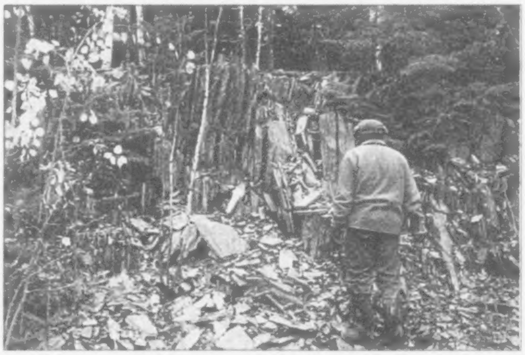
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 28



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 54 51.7 N	67 44 40.9 W
UTM COORDINATES	5307544 N	593795 E
ROAD CLASSIFICATION	CLASS 2 LOGGING ROAD	
DISTANCE	94 km from primary road	108 km from Edmundston

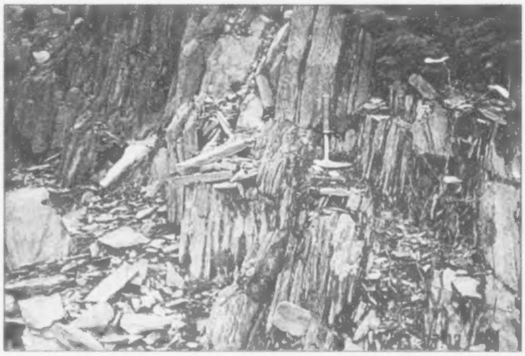


PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	2m to 4m		

	field	harvested	forested
VEGETATION	☐	☐	☑

	flat	undulating	rugged
TERRAIN	☐	☑	☐



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
	sandstone	siltstone	shale /argillite	slate
LITHOLOGY	☐	☐	☐	☑

COLOUR	Medium to dark grey	
	fresh	weathered
MUNSELL NO.	N5	5Y 6/1

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
☐	☑	☐

ROUGHNESS

smooth	☐
rough	☑

FISSILITY

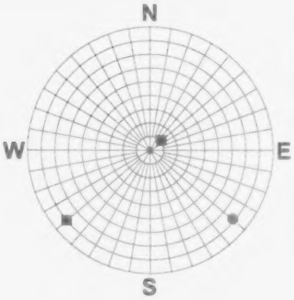
high	medium	low
☑	☐	☐

DELETERIOUS MATERIALS

pyrite	☐
carbonate	☑
quartz	☐
none	☐

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	☐	☐	☑
FAULTS	☐	☐	☑



PLANES	strike	dip	dip direction	spacing mm
● cleavage	220	80	N	5 to 10
▲ bedding	-	-	-	-
■ joint set 1	320	80	N	-
■ joint set 2	140	10	S	400 to 600
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

3 - 6	6 - 7	7 - 10
☐	☐	☑
poor	fair	good

ROCK QUALITY

NOTES

Dark grey to blue-grey slate, weathering to greyish brown.
40 metre long outcrop exposure along roadway. Sandy layers and sand nodules/lenses. Carbonate in sand layers.

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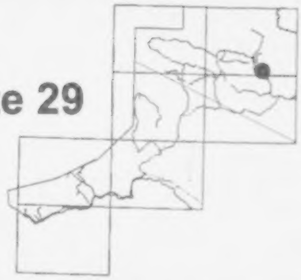
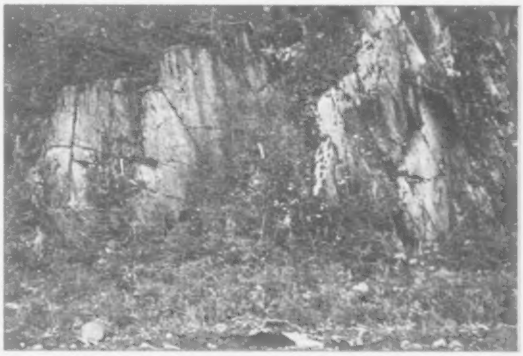
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 29



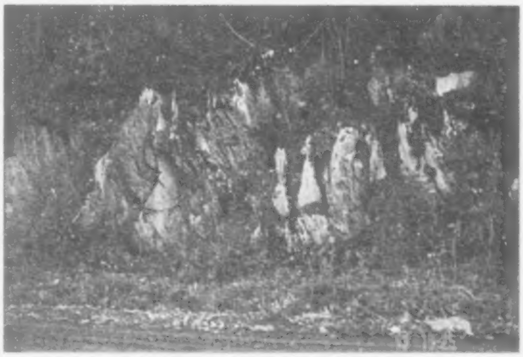
LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 46 44.9 N	67 43 03.1 W
UTM COORDINATES	5292549 N	596074 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	85 km from primary road	98 km from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE		✓				✓	VEGETATION
HEIGHT, metres	> 10 m					✓	TERRAIN
				flat	undulating	rugged	



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				Medium to dark grey		COLOUR
LITHOLOGY			✓				MUNSELL NO.
	sandstone	siltstone	shale /argillite	slate	fresh	weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

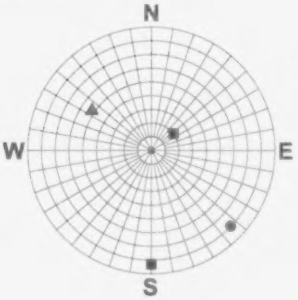
high	medium	low
		✓

DELETERIOUS MATERIALS

pyrite	
carbonate	
quartz	
none	✓

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	225	80	N	-
▲ bedding	031	54	N	-
■ joint set 1	270	85	N	-
■ joint set 2	140	25	S	200 to 750
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

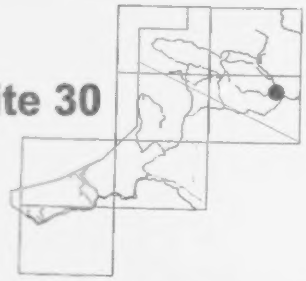
3–6 poor	6–7 fair	7–10 good
✓		

ROCK QUALITY

NOTES

Finely laminated, irregular breakage pattern. Numerous cross cutting/intersectiong fracture planes. Immediately north of mapped fault.

Site 30



LOCATION

SHEET / ZONE	NTS 21 O/12	UTM 19
LATITUDE / LONGITUDE	47 42 40.9 N	67 38 14.3 W
UTM COORDINATES	5285117 N	602216 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	75 km from primary road	89 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	2m to 4m		

	field	harvested	forested
VEGETATION		✓	

	flat	und-ulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
	sand-stone	silt-stone	shale /argillite	slate
LITHOLOGY			✓	

COLOUR	Medium to dark grey	
MUNSELL NO.	N4 fresh	10 YR 4/2 weathered

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

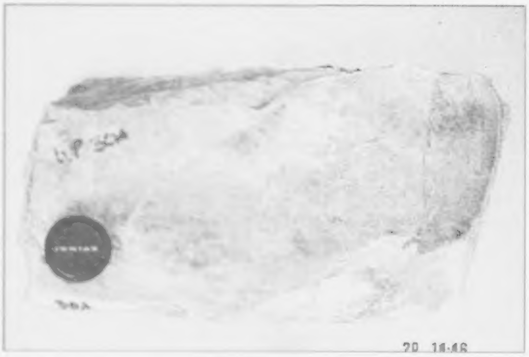
smooth	✓
rough	

FISSILITY

high	medium	low
✓		

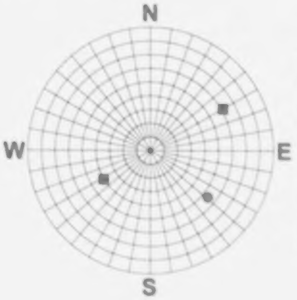
DELETERIOUS MATERIALS

pyrite	
carbonate	✓
quartz	
none	



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS	✓		
FAULTS			✓



PLANES		strike	dip	dip direction	spacing mm
●	cleavage	218	55	W	2 to 5
▲	bedding	-	-	-	-
■	joint set 1	332	40	E	-
■	joint set 2	152	60	W	-
■	joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3–6	6–7	7–10
	poor	fair	good
			✓

ROCK QUALITY

NOTES

Medium to dark grey shale, weathering to light grey to brown grey. Isoclinal folding parallel to cleavage. Preferential weathering along cleavage planes. Weakly carbonate.

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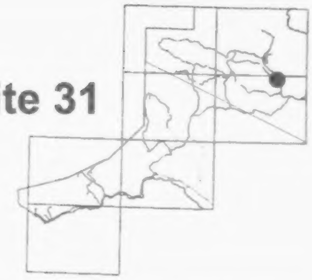
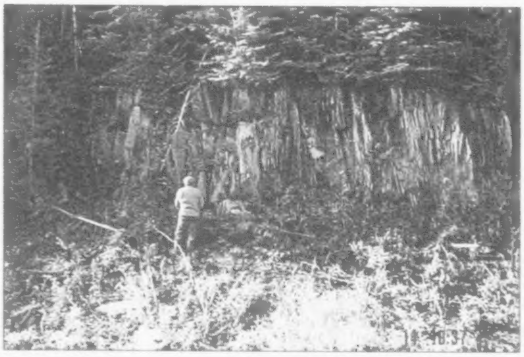
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 31



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 45 12.3 N	67 40 24.5 W
UTM COORDINATES	5289745 N	599422 E
ROAD CLASSIFICATION	CLASS 1 FOREST ROAD	
DISTANCE	81 km from primary road	94 km from Edmundston

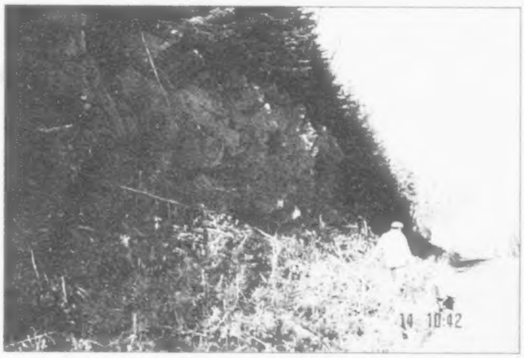


PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	☐	☑	☐
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION	☐	☐	☑

	flat	undulating	rugged
TERRAIN	☐	☐	☑



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sandstone ☐	siltstone ☐	shale /argillite ☑	slate ☐

COLOUR	Medium to dark grey	
MUNSELL NO.	N3 fresh	5Y 4/1 weathered

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
☑	☐	☐

ROUGHNESS

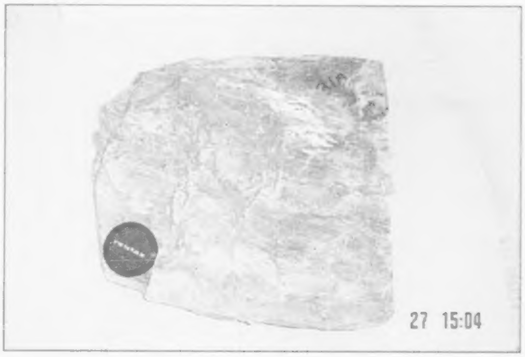
smooth	☐
rough	☑

FISSILITY

high	medium	low
☑	☐	☐

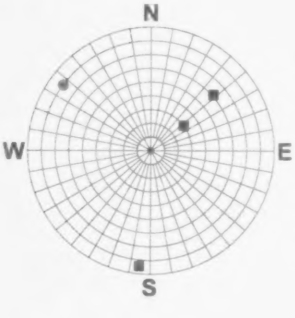
DELETERIOUS MATERIALS

pyrite	☐
carbonate	☑
quartz	☐
none	☐



STRUCTURAL FEATURES

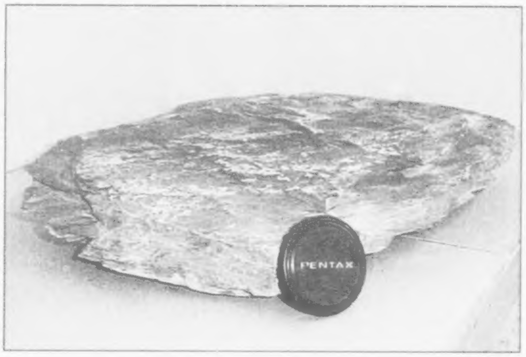
	micro scale	macro scale	none observed
FOLDS	☐	☐	☑
FAULTS	☐	☐	☑



PLANES	strike	dip	dip direction	spacing mm
● cleavage	035	80	S	2 to 10
▲ bedding	-	-	-	-
■ joint set 1	140	30	W	200 to 2000
■ joint set 2	138	60	W	1000
■ joint set 3	275	85	N	-

ROCK QUALITY

ROCK QUALITY FACTOR (RQF)	3–6 poor	6–7 fair	7–10 good
	☐	☐	☑



NOTES

A large outcrop (600 metres long) along roadway. Medium bluish grey shale, weathering to greyish brown. Moderately calcareous. Lenses and thin beds of sandstone. Irregular cleavage surface at shallow angle to bedding.

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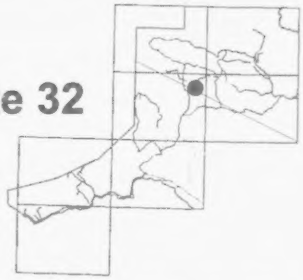
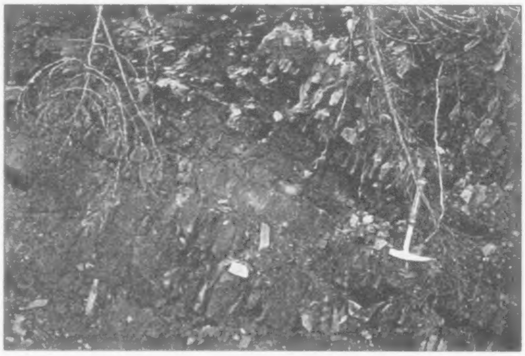
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 32



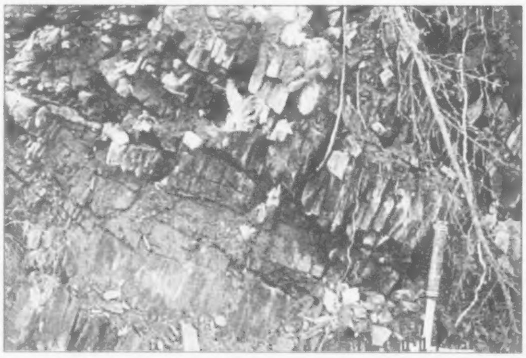
LOCATION

SHEET / ZONE	NTS 21 N/9	UTM 19
LATITUDE / LONGITUDE	47 43 25.3 N	68 03 14.9 W
UTM COORDINATES	5286024.37 N	570932.32 E
ROAD CLASSIFICATION	CLASS 2 LOGGING ROAD	
DISTANCE	42 km	55 km
	from primary road	from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE		✓				✓	VEGETATION
HEIGHT, metres	1 m to 3 m				✓		TERRAIN
				flat	und-ulating	rugged	



ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				Medium to dark grey		COLOUR
LITHOLOGY			✓				MUNSELL NO.
	sand-stone	silt-stone	shale /argillite	slate	fresh	weathered	

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓		

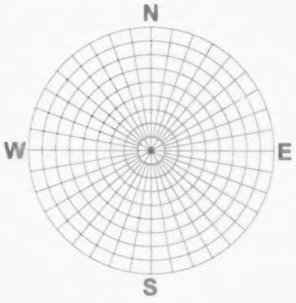
ROUGHNESS	
smooth	
rough	✓

FISSILITY	high	medium	low
		✓	

DELETERIOUS MATERIALS	
pyrite	
carbonate	
quartz	
none	✓

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	-	-	-	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
	✓		
	poor	fair	good

ROCK QUALITY

NOTES

Medium grey shale. Pencil-like cleavage/jointing pattern.
Low relief. Limited outcropping in area.

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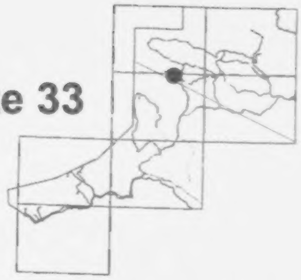
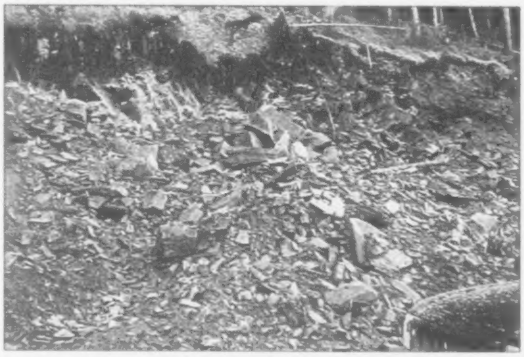
PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 33



LOCATION

SHEET / ZONE	NTS 21 N/16	UTM 19
LATITUDE / LONGITUDE	47 45 25.6 N	68 10 53.1 W
UTM COORDINATES	5289629 N	561349 E
ROAD CLASSIFICATION	CLASS 2 FOREST ROAD	
DISTANCE	44 km from primary road	57 km from Edmundston



PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	2m to 4m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA

	sandstone	siltstone	shale /argillite	slate
LITHOLOGY			✓	

	fresh	weathered
COLOUR	Dark grey	
MUNSELL NO.		

TEXTURE

GRAIN SIZE	fine < 30 um	medium 30 - 50 um	coarse > 50 um
	✓		

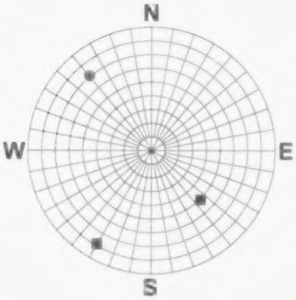
ROUGHNESS	
smooth	
rough	✓

FISSILITY	high	medium	low
			✓

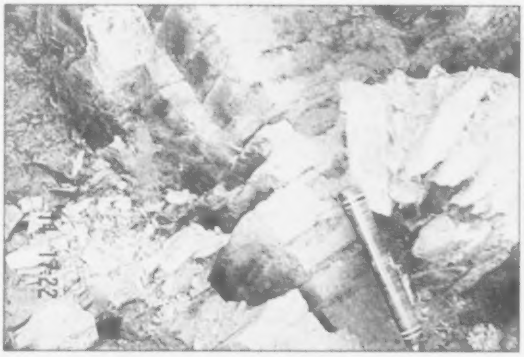
DELETERIOUS MATERIALS	
pyrite	
carbonate	
quartz	
none	✓

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	050	70	S	-
▲ bedding	-	-	-	-
■ joint set 1	300	80	N	50 to 500
■ joint set 2	225	50	W	-
■ joint set 3	-	-	-	-



ROCK QUALITY

ROCK QUALITY FACTOR (RQF)	3 - 6 poor	6 - 7 fair	7 - 10 good
	✓		

NOTES

Limited outcroping of highly fractured shale. Material is being used for repairing haulage roads

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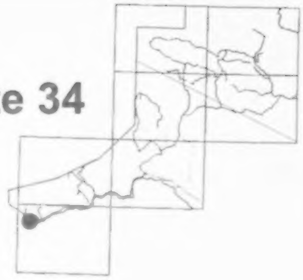
Engineering Limited

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 34



LOCATION

SHEET / ZONE	NTS 21 O/13	UTM 19
LATITUDE / LONGITUDE	47 13 08.8 N	68 57 22.8 W
UTM COORDINATES	5229512 N	503305 E
ROAD CLASSIFICATION	CLASS 4 TEMPORARY ROAD	
DISTANCE	2 km from primary road	63 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE	✓		
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION		✓	

	flat	und-ulating	rugged
TERRAIN	✓		

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			

	sand-stone	silt-stone	shale /argillite	slate
LITHOLOGY			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.		

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

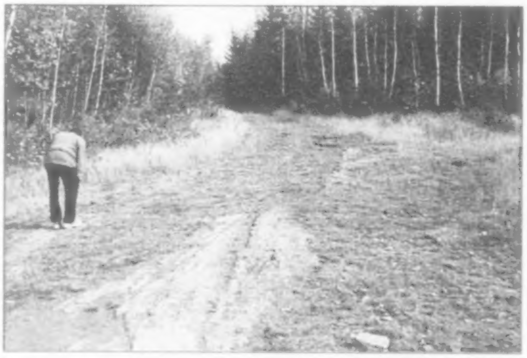
smooth	✓
rough	

FISSILITY

high	medium	low
	✓	

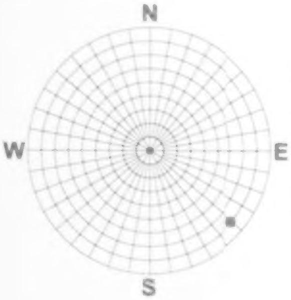
DELETERIOUS MATERIALS

pyrite	
carbonate	
quartz	✓
none	



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓

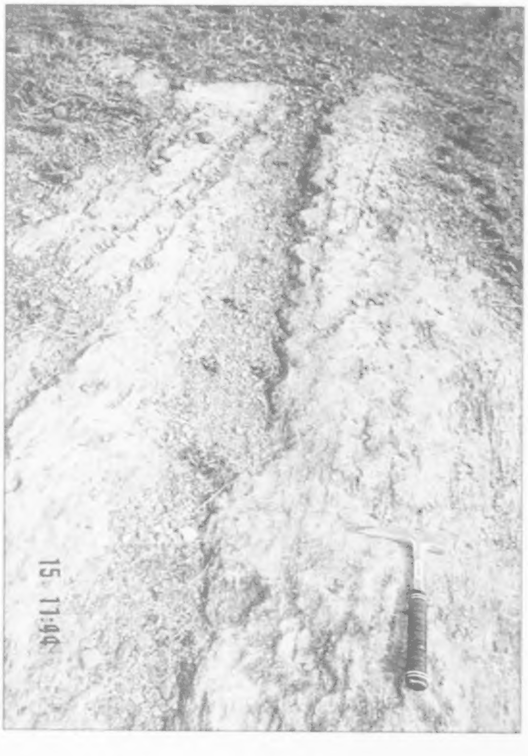


PLANES	strike	dip	dip direction	spacing mm
● cleavage	222	80	N	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

poor (3 – 6)	fair (6 – 7)	good (7 – 10)
	✓	

ROCK QUALITY

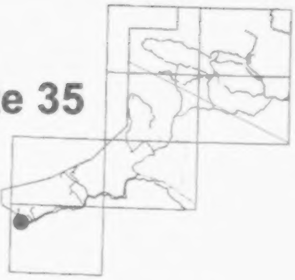


NOTES

Large outcroping (30 m x 15 m) with little to no relief.

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 35



LOCATION

SHEET / ZONE	NTS 21 N/02	UTM 19
LATITUDE / LONGITUDE	47 13 23.6 N	68 57 28.1 W
UTM COORDINATES	5229970 N	503194 E
ROAD CLASSIFICATION	CLASS 4 TEMPORARY ROAD	
DISTANCE	2 km from primary road	63 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	undulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

	sandstone	siltstone	shale /argillite	slate
FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.	N5	10 YR 4/2

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

smooth	✓
rough	

FISSILITY

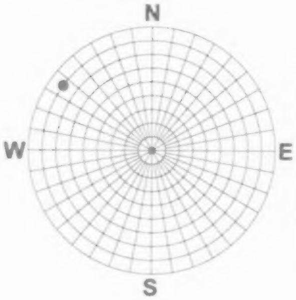
high	medium	low
✓		

DELETERIOUS MATERIALS

pyrite	
carbonate	
quartz	✓
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES

	strike	dip	dip direction	spacing mm
● cleavage	035	80	SE	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

poor (3 – 6)	fair (6 – 7)	good (7 – 10)
	✓	

ROCK QUALITY

NOTES

Dark grey shale/siltstone, weathering to medium to dark brown. Thinly laminated with quartz veining. Preferential weathering noted along irregular cleavage planes. Low relief.

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Engineering Limited

PRELIMINARY SURVEY OF SELECTED CROWN LAND SLATE RESOURCES IN NORTHWESTERN NEW BRUNSWICK

Site 36

LOCATION

SHEET / ZONE	NTS 21 N/2	UTM 19
LATITUDE / LONGITUDE	47 12 48.7 N	68 57 25 W
UTM COORDINATES	5228894.18 N	503260.95 E
ROAD CLASSIFICATION	CLASS 4 TEMPORARY ROAD	
DISTANCE	2 km from primary road	63 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry
EXPOSURE TYPE		✓	
HEIGHT, metres	4m to 10m		

	field	harvested	forested
VEGETATION			✓

	flat	und-ulating	rugged
TERRAIN			✓

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA			
LITHOLOGY	sand-stone	silt-stone	shale /argillite	slate
			✓	

	fresh	weathered
COLOUR	Medium to dark grey	
MUNSELL NO.		

TEXTURE

ROUGHNESS

smooth	✓
rough	

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

FISSILITY

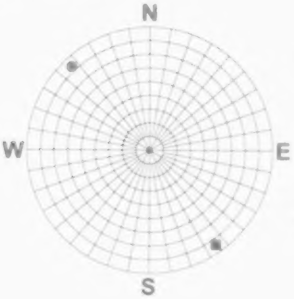
high	medium	low
✓		

DELETERIOUS MATERIALS

pyrite	✓
carbonate	
quartz	
none	

STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS			✓



PLANES	strike	dip	dip direction	spacing mm
● cleavage	045	85	S	-
▲ bedding	-	-	-	-
■ joint set 1	145	85	W	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

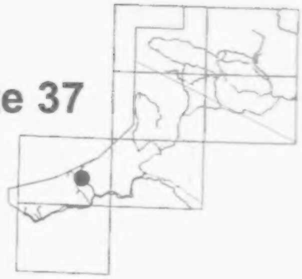
ROCK QUALITY FACTOR (RQF)	3 – 6	6 – 7	7 – 10
			✓
	poor	fair	good

ROCK QUALITY

NOTES

Located on Freehold 200 m southwest of Crown land boundary.
Medium grey to black shale, weathering to brownish green.
Major joint set along cleavage plane.

Site 37



LOCATION

SHEET / ZONE	NTS 21 N/07	UTM 19
LATITUDE / LONGITUDE	47 22 39.7 N	68 39 58.2 W
UTM COORDINATES	5247191.64 N	525202.67 E
ROAD CLASSIFICATION	CLASS 3 WINTER ROAD	
DISTANCE	2 km from primary road	42 km from Edmundston

PHYSICAL DESCRIPTION

	natural outcrop	road cut	quarry	field	harvested	forested	
EXPOSURE TYPE	✓					✓	VEGETATION
HEIGHT, metres	4m to 10m					✓	TERRAIN
				flat	undulating	rugged	

ROCK DESCRIPTION

FORMATION/UNIT	TEMISCOUATA				Medium to dark grey	COLOUR
LITHOLOGY	✓					MUNSELL NO.
	sandstone	siltstone	shale /argillite	slate	fresh / weathered	

TEXTURE

GRAIN SIZE

fine < 30 um	medium 30 - 50 um	coarse > 50 um
✓		

ROUGHNESS

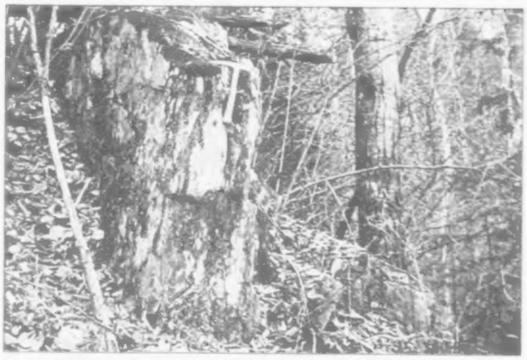
smooth	✓
rough	

FISSILITY

high	medium	low
	✓	

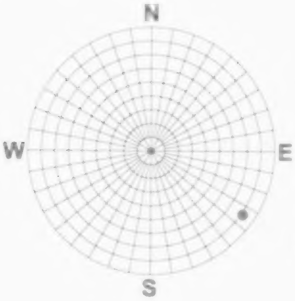
DELETERIOUS MATERIALS

pyrite	
carbonate	
quartz	✓
none	



STRUCTURAL FEATURES

	micro scale	macro scale	none observed
FOLDS			✓
FAULTS		✓	

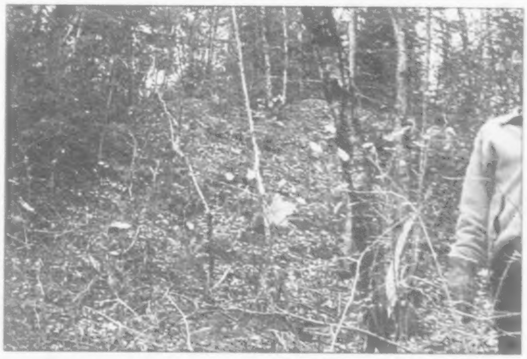


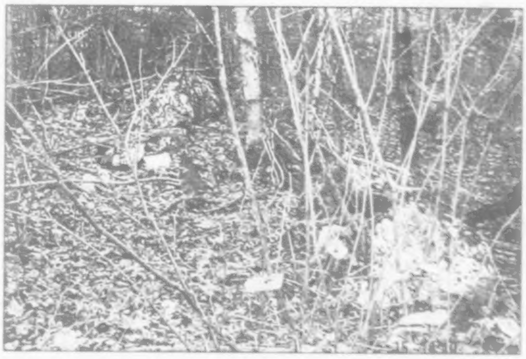
PLANES	strike	dip	dip direction	spacing mm
● cleavage	216	80	N	-
▲ bedding	-	-	-	-
■ joint set 1	-	-	-	-
■ joint set 2	-	-	-	-
■ joint set 3	-	-	-	-

ROCK QUALITY FACTOR (RQF)

3 - 6 poor	6 - 7 fair	7 - 10 good
✓		

ROCK QUALITY





NOTES

Limited outcrop exposure. Located 20 to 30 metres west roadway.
Dark grey siltstone/sandstone weathering to brown grey.
Numerous large quartz boulders (up to 1 m^3).

APPENDIX C - SELECTED LABORATORY TEST DATA

C1 - Absorption data

Table C1 - Absorption data for selected slate and slate-like materials from northwestern New Brunswick

Site/Sample #	Air Dry Weight (g)	Wet Weight (g)	Oven Dry Weight (g)	Absorption %
3	253.14	254.25	251.74	1
4	323.85	327.78	321.83	1.85
9	328.96	336.15	326.28	3.03
10	403.83	413.48	397.23	4.09
11	249.69	251.21	256.76	1.8
16	343.8	345.26	342.57	0.78
17	307.34	308.23	306.68	0.51
18	262.22	263.37	259.1	1.65
19	301.91	307.71	299.33	2.8
21	258.66	260.58	255.08	2.16
23	300	308.17	298.93	3.09
24	361.4	365.43	360.19	1.45
27	256.78	257.54	255.26	0.89
28	261.59	263.9	258.35	2.15
30	318.69	323.86	316.15	2.44
31	253.91	256.81	251.69	2.03
35	314.08	315.24	310.43	1.55
36	324.04	326.86	320.88	1.86

(ASTM C121-90)

C2 - Point load test data

Tabie C2 - Point load test data for selected slate and slate-like materials in northwestern New Brunswick.

SAMPLE #	THICKNESS (mm)	LENGTH (mm)	BREADTH (mm)	POINT LOAD (kN)	ORIENTATION	EQUIVALENT CORE DIAMETER (mm^2)	UNCORRECTED POINT LOAD STRENGTH (MPa)	CORRECTED POINT LOAD STRENGTH (MPa)	ESTIMATED COMPRESSIVE STRENGTH (MPa)
3-1	49	53.2	52	12.9	perpendicular	3257	3.98	4.22	103
3-2	49	54.3	53.6	18.5	perpendicular	3365	5.51	5.89	145
3-3	54	60.4	58.4	1.9	parallel	4030	0.49	0.54	14
3-4	53	51.1	51.3	3.4	parallel	3474	0.98	1.05	26
4-1	45	52.3	52.8	12.8	perpendicular	3057	4.20	4.40	106
4-2	42	51.8	52	15.8	perpendicular	2803	5.64	5.79	137
4-3	35	51.3	54.8	10.5	perpendicular	2345	4.49	4.43	100
10-1	25	57.5	51.8	10.8	perpendicular	1702	6.36	5.83	124
10-2	28	53.4	54	7.2	perpendicular	1965	3.70	3.51	77
10-3	26	58.4	43.1	13.1	perpendicular	1432	9.18	8.10	167
11-1	41	56.6	49.2	7.2	perpendicular	2587	2.80	2.82	65
11-2	25	54.2	50.1	9.5	perpendicular	1646	5.83	5.30	112
11-3	28	59.1	21.3	10.2	perpendicular	776	13.25	10.19	189
17-1	49	53.8	41.5	15.8	perpendicular	2610	6.07	6.13	142
17-2	46	56	52.9	21.2	perpendicular	3132	6.79	7.14	173
17-3	49	54.3	52.5	21.9	perpendicular	3302	6.64	7.07	173
18-1	46	50.9	54	7.8	perpendicular	3014	2.59	2.71	65
18-2	49	51.8	57.2	12.5	perpendicular	3245	3.86	4.09	100
18-3	47	57.7	50	9.7	perpendicular	3018	3.21	3.35	80
19-1	41	52	47.4	13.3	perpendicular	2505	5.31	5.32	122
19-2	43	52.1	50.5	16.8	perpendicular	2816	6.00	6.16	145
19-3	51	41.2	51.9	3.7	parallel	2723	1.37	1.39	33
19-4	42	49.8	52.1	18.6	perpendicular	2669	6.98	7.08	165
21-1	49	53.7	52.6	7.1	perpendicular	3288	2.17	2.31	57
21-2	54	49.6	52.4	7.7	perpendicular	3467	2.24	2.41	60
23-1	33	51.5	50.3	4.0	perpendicular	2145	1.88	1.81	40
23-2	35	50.2	49.2	9.0	perpendicular	2205	4.10	3.98	89
23-3	30	51.1	51.4	13.0	perpendicular	1952	6.69	6.33	138
24-1	39	56.2	53.9	17.6	perpendicular	2711	6.50	6.62	155
24-2	35	57.5	51.5	15	perpendicular	2295	6.88	6.75	152
24-3	34	53.3	57.2	20	perpendicular	2368	8.66	8.55	194
27-1	41	58.1	52.8	17.6	perpendicular	2817	6.28	6.45	152
27-2	49	57.7	52.7	27	perpendicular	3308	8.40	8.95	219
27-3	48	51.8	56.7	20	perpendicular	3179	6.48	6.84	166
28-1	46	52.9	56.1	7.6	perpendicular	3159	2.41	2.54	61
28-2	49	56.6	53.8	5.1	perpendicular	3384	1.52	1.63	40
28-3	46	52.9	56.3	7.5	perpendicular	3112	2.42	2.54	61
30-1	23	52.9	57	5.9	perpendicular	1596	3.71	3.36	70
30-2	23	52.8	52.5	11.7	perpendicular	1544	7.62	6.83	143
30-3	23	52.4	65	8.9	perpendicular	1541	5.79	5.20	108
31-1	50	86.8	64.8	12.9	perpendicular	4150	3.11	3.49	90
31-2	56	63.7	54.9	6.1	perpendicular	3942	1.57	1.74	44
31-3	55	57.7	62.7	5.1	parallel	4092	1.25	1.39	36
31-4	55	53.1	62.2	1.8	parallel	3766	0.49	0.54	14

ASTM D5731-95 - Point Load Strength Index of Rock

Discussion

The point load tests were conducted in an MTS electro hydraulic servo-control testing machine. In most cases samples were loaded with the load axis oriented perpendicular to the cleavage. The failure loads under point load were typically quite high suggesting correspondingly high compressive strengths, but this is quite misleading. In practice, the tested slates were relatively soft, and conventional shear failure did not occur. Instead, the conical point pushed into the compressible rock fabric causing layer after layer to flake off. In some cases, failure strains were as high as 50 percent (the point load test was not really designed for rock this soft).

The method of failure in all “perpendicular” tests were consistent and as follows: the outer layers (both upper and lower) failed first, usually at around 5 to 7 kN. These outer layers then fell away and the sample stabilized and was able to take more load. The next outermost layers then failed and then they fell off and the sample stabilized again. This process continued until the sample finally failed completely or until it was obvious that the sample would not be able to take more load. The values reported in the appended Table C2 are the "ultimate" load observed in each test.

The “parallel” tests were more predictable, the samples split at relatively low loads and failure strains were very small.

C3 - Flexural strength test data

Bodycote MATERIALS TESTING CANADA INC. www.na.bodycote-mt.com

2395 SPEAKMAN DRIVE, MISSISSAUGA, ONTARIO CANADA L5K 1B3 • TEL: (905) 822-4111 • FAX: (905) 823-1446

EVALUATION OF FLEXURE PROPERTIES OF VARIOUS SLATE ROOFING TILES

Report to: **TerrAtlantic Engineering Limited**
515 Beaverbrook Court
Fredericton, NB
E3B 1X6

Attention: Mr. Aaron Alderman

Telephone: 506-460-8660
Fax: 506-460-8679

Report No.: 04-06-M0381
3 Pages

Quotation No.: 04-06-097

Date: January 31, 2005

1.0 INTRODUCTION

At the request of TerrAtlantic Engineering Limited, Bodycote Materials Testing Canada Inc. was retained to evaluate the flexure properties of various slate roofing tiles as outlined in BMTC Quotation 04-06-097.

Upon receipt, the samples were assigned the following Bodycote Sample Numbers:

Client Sample Description	Bodycote Sample No.
29801-04A	04-06-M0381-1
29801-04B	04-06-M0381-2
29801-04C	04-06-M0381-3
29801-17A	04-06-M0381-4
29801-17B	04-06-M0381-5

2.0 PROCEDURE

The samples were evaluated in accordance with the following standard listed below:

Test Description	Test Method
Flexure Testing of Slate (Modulus of Rupture, Modulus of Elasticity)	ASTM C120-00

3.0 RESULTS

Table 1 – Summarized Flexure Properties Results (ASTM C120-00)

Bodycote Sample Number	Modulus of Rupture (MPa)	Modulus of Elasticity (MPa)
04-06-M0381-1 *	N/A	N/A
04-06-M0381-2 **	N/A	N/A
04-06-M0381-3	15.97	6160.0
04-06-M0381-4	30.40	1767.0
04-06-M0381-5	43.15	19740.0

* Specimen cracked during dry conditioning.
** Instron data acquisition system failure.

Reported by:

Jordan Church, Ext. 546
Project Technologist
Building Performance Centre

Approved by:

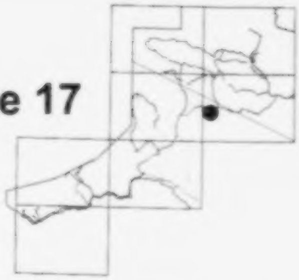
David Bailey, P.Eng., Ext. 307
Operations Manager
Engineering & Transportation

This report refers only to the particular samples, units, material, instrument, or other subject used and referred to in it, and is limited by the tests and/or analyses performed. Similar articles may not be of like quality, and other testing and/or analysis programs might be desirable and might give different results.

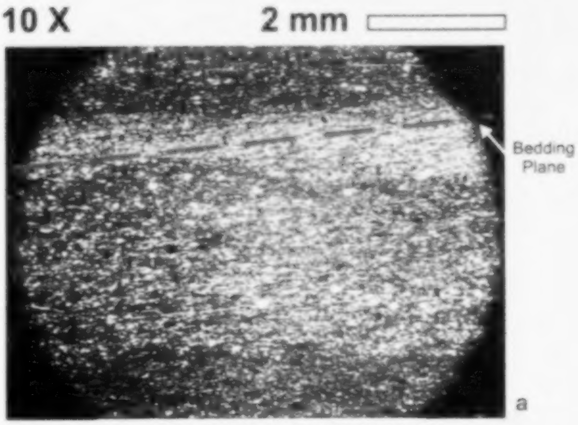
ACCREDITATION
Canadian General Standards Board #76002, Standards Council of Canada #1.

REGISTRATION
ISO 9001:2000 registered by QMI, Registration #00110

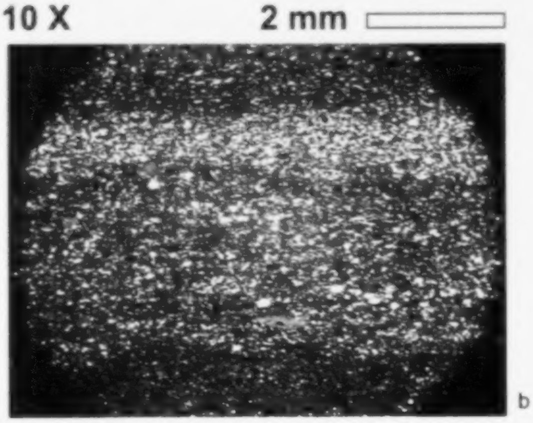
C4 - Thin section data



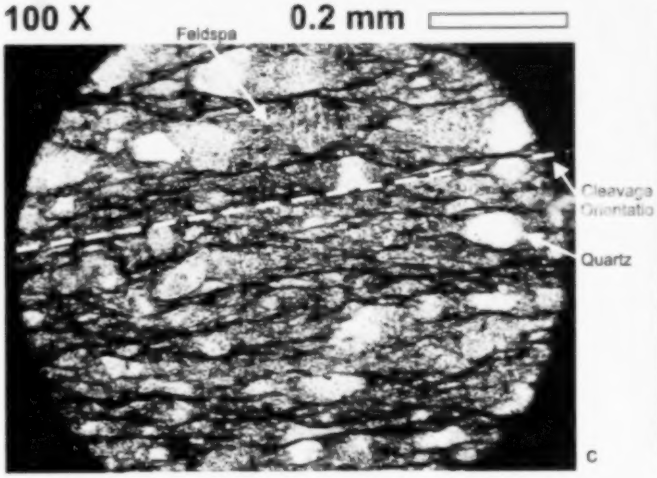
Petrographic examination of selected slate samples from northwestern New Brunswick - Sample 17



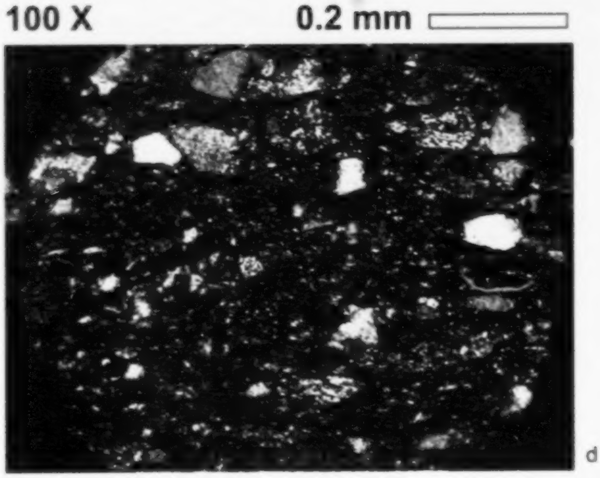
Photomicrograph showing bedding; Plane polarized light.



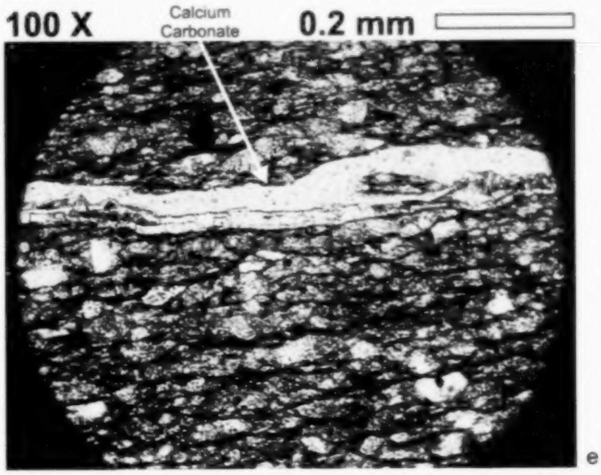
Same as in (a) under cross polars.



Photomicrograph showing cleavage with clear quartz and altered feldspars; Plane polarized light.



Same as in (c) under cross polars.



Photomicrograph showing vein of calcium carbonate; Plane polarized light.

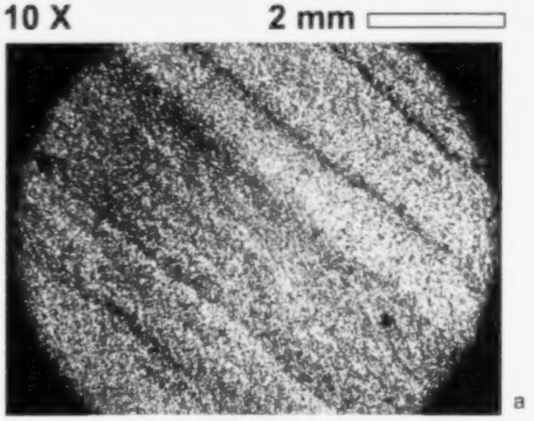
The following are the main mineral components of the rock as noted from petrographic (thin section) examination:
Quartz
Feldspars (plagioclase and K-spar)
Chlorite
Matrix
Opaques
Sphene (Leucoxene?)

Alternating layers displaying grain size variation of the mineral constituents defines bedding. It appears that coarser beds contain a higher percentage of quartzo-felspathic minerals. The overall grain size range is 0.015 - 0.042 mm.

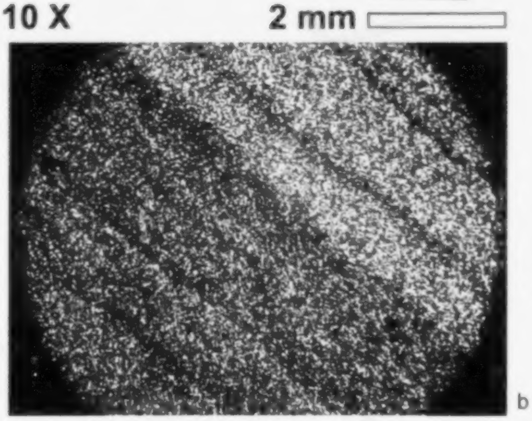
Clastic grains of quartz, feldspar and chlorite, that constitute about 30 per cent of the rock, occur in a clay and /or silty matrix. The matrix is altered to microcrystalline micas and clay minerals during compaction and recrystallization. Although most of the micaceous material is oriented parallel/subparallel to the cleavage, there are some which are randomly oriented. The cleavage planes intersect the bedding surfaces at a small angle of about 15 degrees.

Clasts generally display subangular to subrounded shapes. Most show varying degrees of flattenning and elongation parallel/subparallel to the cleavage. Feldspar clasts are variably altered to mica and clay minerals. Higher proportion of micaceous and clay minerals indicate that the feldspar content was higher than that of quartz.

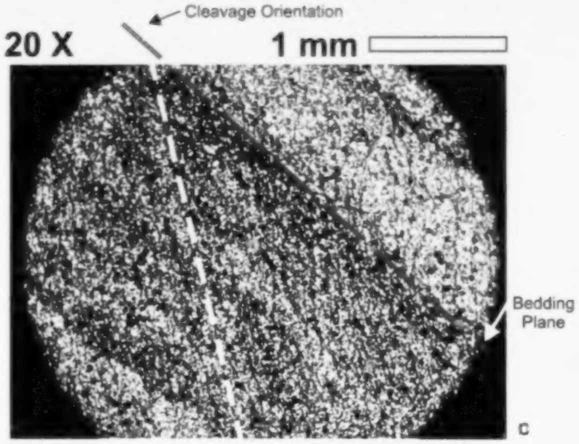
Petrographic examination of selected slate samples from northwestern New Brunswick - Sample 24



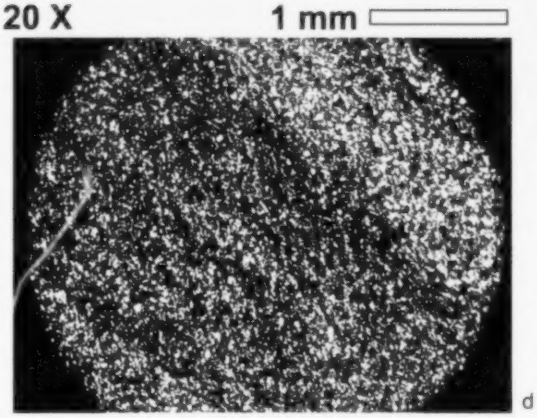
Photomicrograph showing bedding; Plane polarized light.



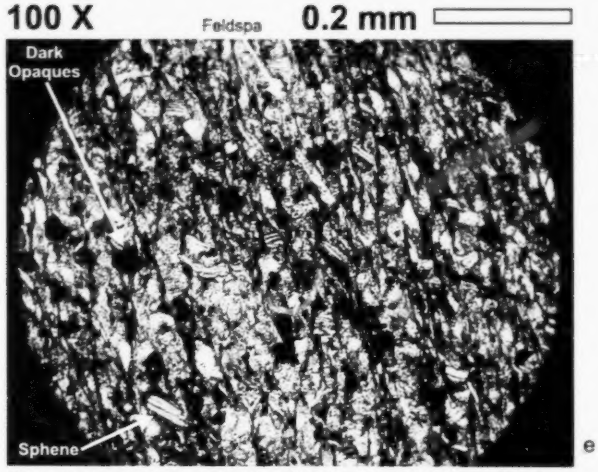
Same as in (a) under cross polars.



Photomicrograph showing cleavage intersecting bedding; Plane polarized light.



Same as in (c) under cross polars.



Photomicrograph showing alteration of feldspars and dark opaques and sphene; Plane polarized light.

The following are the main mineral components of the rock as noted from petrographic (thin section) examination:

Quartz
Feldspars (plagioclase and K-spar)
Chlorite
Matrix
Opaques
Sphene(Leucoxene?)
Tourmaline (rarely)

Alternating layers displaying grain size variation of the mineral constituents defines bedding. It appears that coarser beds contain a higher percentage of quartzo-felspathic minerals. The range of the grain size is 0.02 - 0.45 mm.

Irregular to subrounded clastic grains of quartz, feldspar and chlorite are embedded in a microcrystalline micaceous silty/clay matrix. The matrix has undergone compaction and recrystallization. Tiny flakes of sericite, muscovite and chlorite(?) with ragged boundaries lie parallel/subparallel to the cleavage surfaces. A small percentage of the micas occur in random orientation. The cleavage planes intersect the bedding surfaces at an angle of about 40 degrees.

Tiny (0.01 - 0.02 mm in diameter) grains of sphene (leucoxene)? with a rind of brown iron oxide occur randomly distributed throughout the rock.

The feldspars are variably altered to clay minerals and micas. A few grains of unaltered plagioclase display albite twinning. The amount of micaceous and clay minerals suggest that the rock contains higher proportion of feldspars in comparison to quartz.

OVERSIZE MAP
NOT FILMED

CARTE SURDIMENSIONNÉE
NON REPRODUITE

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